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THE NEW YEAR.

The new year opens with the fullest promise of enlargement in all the many departments of the electrical field. The year just past has been one of recovery, and despite many unfavorable conditions the electrical arts have made excellent and satisfactory progress in 1897. It is to the coming twelvemonth, though, that we look for the greatest electrical advancement in recent years. With no disturbing causes visible, and only encouragement in sight, it is more than pleasant for THE ELECTRICAL WORLD to wish its readers a measure of prosperity no less full than the promise of the ensuing season.

CURRENT DISTRIBUTION FOR ELECTRIC TRACTION.

As the length of electric railways increases new problems arise in the methods of conduction and distribution of the current from a single source of generation to the motors. American practice has crystallized upon 500 volts as the most available working pressure, partly on account of the dangerous nature of higher potentials and partly because of difficulties of insulation in both line and motors when this limit is exceeded. With the standard systems of electric traction the limit of economical distribution at this pressure is reached far within the distances frequently required and the railway engineer is confronted with the necessity of additional generating stations, or some departure from the usual methods, in order to reduce line losses or to save excessive costs for conductors.

When direct currents are adhered to throughout, there are several methods available so long as the pressure on the working conductors remains at the conventional figure. Boosting, over-compounding of the generators, motor generators and three-wire distribution are perhaps the commonest of these. Over-compounding, while a fairly satisfactory method if the generating station is a single unit, does not readily conform to the necessities of stations where many units are used, since in this case the heavily over-compounded machines form a system to themselves, not available for operation in multiple with standard types of generators, and generally requiring separate engines for their propulsion. With boosters the difficulty is the necessity of a separate line of feeders for each boosted section. Prevailing practice, when boosters are used, has favored motor driving rather than engine driving for them, since the comparatively small engine units required fail in efficiency, and a distinct gain is made in driving these machines by electrical transmission from the main generators. The major difficulty with either over-compounding or boosting lies, however, in the fact that both these methods are makeshifts, and that neither shows high efficiency. The resistance of the feeders has to be overcome with a continual expenditure of energy, rising in a geometrical ratio with the load. The greatest obstacle in the way of long-distance distribution is not conquered by the use of these methods, but only evaded with a corresponding loss of power.

The three-wire system is admirable where there is a considerable number of cars or a high uniform load. With few cars, or at times of small load, the unbalancing of the system may lead to more or less serious trouble, or necessitate the use of some form of equalizing machine. With motor-generators excellent results may be had, but the troubles of commutation with currents of high tension are serious, and the machines themselves expensive. The method has so far been used but little, on account of obvious inherent difficulties.

With polyphase transmission and rotary transformers feeding sections of the line, the troubles of conductor loss may be largely avoided. By a simple increase of the pressure at the generating station the line loss is reduced, the currents being subsequently transformed with small loss through a system of stationary and rotary converters into an easily governed and controlled direct current for feeding the car motors. Here again, however, a difficulty presents itself, since the transformer stations are expensive to build, and require attendance. Current is saved, line loss is diminished, regulation is bettered, but at considerable cost, comparable indeed to that of a booster system with heavy feeders.

There is a solution, however, to which all modern practice points—the use of alternating motors directly upon the cars. While it is true that there are only two or three railways in the world at present equipped with this system, there is no reason whatever why there should not be more. As Mr. Steinmetz has pointed out in another column, the polyphase induction motor is susceptible of about the same variety of control as the ordinary direct-current machine. The only difficulty seems to be in the conducting system, which necessitates at least two conductors in addition to the track. In a conduit, with the fixed and solid construction generally used in this class of work, these difficulties vanish. Even with overhead conducting systems it presents no difficulty that does not seem easy of solution.

Professor Blondel has suggested, in this issue, a return to the time-honored series system, but the ingenious, though impracticable, method he outlines is only susceptible of use on lines where the traffic is very uniform, and not liable to interruption, while even in this case the enormous potentials that would result from the operation of any considerable number of motor cars would produce endless trouble from burnouts and much danger. Looked at in the broadest way, the alternating current motor seems to offer the best and most reasonable solution to the problem of long distance electric railway work, and its future use can be confidently predicted.

A TENDENCY OF PROGRESS.

The evolution of the electric arts from their small beginnings, a half century or more ago, has been a singular story of progression, first along one line and then another, changing, as the accumulation of knowledge crystallized into coherent theories of electrical action, into a more purposeful growth. To-day the development of the heavy-current applications seems to be on the eve of transition—apparently returning to the simple prinicples of former days, and discarding much that was the product of hard study and harder labor in its perfection.

When the first dynamos were built it was found necessary to introduce a device for straightening the pulses of current that flowed from their armatures first in one way and then in the other, into an orderly current, something like that given by Volta's pile or Galvani's "Crown of Cups." The commutator was invented, elaborated, and, after much travail, perfected as far as such a thing could be perfected. Electricians viewed the chaotic currents emanating from the whirling wire with disfavor. They would not energize an electromagnet, they would not work a telegraph, so the commutator was called into being to rectify them. Later, when motors had progressed beyond the stage of scientific curiosities, commutators were used upon them to again distribute the straightened current into its elements.

Henry and Faraday had found out that pulses of current induced others in neighboring conductors. Ruhmkorff had made the secondary conductor long and coiled it many times about the primary. Finally somebody reversed one of his coils and found that "intensity" currents could be made to give "quantity" effects, as well as *vice versa*. This was the first step in the progress of the alternating current. Jablochkoff and Gaulard and Gibbs and others of that day worked out a system of alternating-current lighting, while Siemens and Von Alteneck made dynamos that were the medical magnetic shocking machines of former days grown to larger proportions. From these small beginnings, by slow steps at first, the modern alternating and polyphase systems have sprung.

To-day the commutator is sinking slowly into comparative obscurity. A new race of dynamo mechanisms has grown up, commutatorless, of the original simplicity of the sine-wave current. It is a return to first principles, a going back to the current conditions that puzzled and appalled the early experimenters, and caused them to devise the rectifying sliding contact machine that has given such a world of trouble ever since. Who is there to-day who shall say that the direct current is the normal variety or deny the alternating its claim at least to priority of origin? At best turning it into direct current was a makeshift resorted to in the early days, because it was not then known how to utilize it in its original simplicity. Happily we are now learning how, and the obvious and manifold advantages of the alternating current are beginning to be appreciated.

It is in this direction that one of the most evident tendencies of present progress is directed. The great lighting stations are changing over from the complex methods formerly in vogue, to the simple and satisfactory polyphase system of generation and supply. Long-distance power transmission is a commercial possibility only for the alternating current. The last stronghold of the direct current, the railway, is now being invaded by its rival, and before many more years shall have passed the applications of direct current will be restricted to those uses for which it alone is fit. Even the one advantage of the direct current, long contended for, the possibility of its use in connection with accumulators, is nullified by the rotary converter.

There is no other tendency so conspicuous as this. The substitution of alternating for direct-current methods is becoming more and more widespread. The great installations now under construction are practically all of the alternating type. In railway work the day cannot be far distant when the commutator motor will be regarded only as an evil memory. Even in telegraphy and telephony the alternating curent is coming into use. Such, to-day, seems the most marked direction of advance in the electrical field, and no doubt ensuing years will see the practical disappearance of much of the direct-current apparatus now used for many purposes.

ELECTRICITY IN THE GREATER NEW YORK.

The most highly developed application of scientific methods is almost always to be found in the great cities. In the country districts people live as yet very much as their forefathers lived, obtaining the means of satisfying the greater part of their daily wants immediately from the work of their own hands, while in the cities life becomes far more sharply differentiated and the needs of the people much more complex. During the last few years there has grown up almost imperceptibly at first the application of electricity to various luxuries, which have finally come more and more widely into use, until they have become absolute necessities and have reached most surprising magnitudes. In the City of Greater New York, which comes into existence on the first day of January, 1898, it will be found that electricity is used to an extent, which would a few years ago have been thought incredible. The modern office building would be almost impossible and decidedly less comfortable without electric current to light it and transmit power through it for all sorts of purposes. The problems of local transportation would be almost insoluble in a city so large, without the aid of electricity. The transaction of business would be something totally different, no one

knows exactly what, without the telegraph and telephone. Without the electric current such a large city would hardly be habitable, and the more the city grows the more absolutely necessary does electricity become.

WHAT TAKES PLACE INSIDE A ROTARY CONVERTER?

The rotary converter in which alternating and direct currents are mutually interchanged in one single winding, is subject to some very peculiar actions, which do not seem hitherto to have been carefully investigated. In another column in this issue there will be found the first installment of an analytical discussion of some of these phenomena, which brings out some points of interest. This first number discusses only the single-phase rotary, which is not used to any great extent, although some machines have been manufactured and put to work on the old-fashioned single-phase alternating systems for the supply of motors necessitating, in the present state of the art, direct current, such as elevator motors, etc. The treatment of the single-phase, however, being more simple than that of the multiphase, is taken up first. Looking at the question in a rather superficial way, it generally appears that as the alternating current goes into the armature coils in a general direction opposite to that in which the direct current comes out, the two appear to partially neutralize each other, and reduce the internal losses of the machine. Such has been the widely prevalent idea, but by a simple application of the calculus it is shown that it is not the fact, for, on the contrary, the resultant of the two gives larger aggregate $C^2 R$ loss in the armature coils than would the direct current alone, even in the best possible case, namely, that of unity power factor. When the power factor runs down this is much aggravated, and, worse yet, the heating is greatly concentrated on certain sections of the winding, so that the conclusion is drawn that a single-phase rotary under ordinary commercial conditions should not be considered capable of transforming more than one-half as much current as it could generate as a direct-current machine. Other interesting peculiarities of the single-phase rotary are also pointed out, such, for example, as the alternating field distortion, which, altogether, make the use of such machines quite undesirable.

The discussion of the multiphase machines shows quite different results, and these will be taken up in order, and the comparative merits of the different types estimated, so far as this can be done from a purely analytical discussion of the internal combinations of the currents.

ALTERNATING-CURRENT MACHINERY.

The serial article by Professor Edwin J. Houston and Dr. A. E. Kennelly, which has been running for some time in THE ELECTRICAL WORLD, will be continued in the forthcoming volume, but with the next installment there will be a change in the character of the matter. The mathematical treatment of the subject being now finished, the description of alternating-current machinery and methods will be taken up from the standpoint of actual practice, and this, with appropriate data, will form the subject matter of the succeeding installments. Even those readers who have not seen the portion of the serial already published, as well as those who may not have followed the mathematical treatment of the subject, will find the future installments full of practical value and interest, while all are to be congratulated that this somewhat obscure subject is being made plain for them by authors of such ability.

THE PAST YEAR AND THE FUTURE.

The industrial art known by the name of electrical engineering is apparently at the present time undergoing its most rapid development. Certain it is that in its practical applications electricity has made greater strides during 1897 than in any preceding year. Whether the present activity is as great as will be found in the future is a matter impossible to determine. In the rapidity of this growth, it is well to stop occasionally and attempt to catch one's breath, and see just what has been done in some given period. In its first issue of every year THE ELECTRICAL WORLD endeavors to review the progress of the year just past, taking up the subject in the different countries of the world, and giving articles by leading writers on the particular improvements in their own departments. The maximum of progress that has been reached during the last year has made this undertaking a difficult one, and the attempt to adequately cover this field has made this the largest issue of an electrical journal that has ever been published. In this review of the progress of the past year an effort is made to find the tendency of development and thereby foretell so far as this can be done the progress of the immediate future. Many indications of this will be found in the following columns. It will be the aim of the editors to maintain through succeeding issues the standard set for the new volume by this initial number.

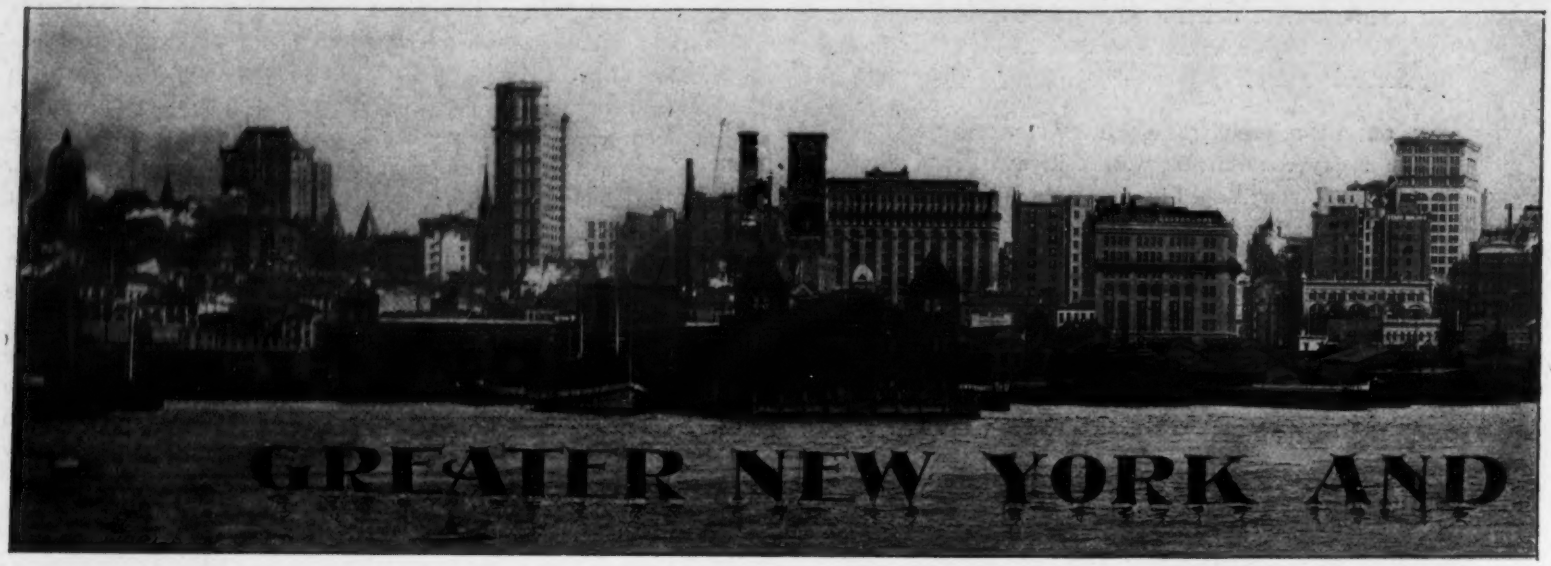
ELECTROLYSIS OF BRIDGE STRUCTURES.

The opponents of the extension of the Brooklyn trolley systems across the New York and Brooklyn Bridge have brought up a new and quite interesting argument concerning the possible effect of the return currents on the main structure. It is claimed that the return current will seek the bridge structure and return via the main support cables to the Brooklyn end, thence going to ground on its way to the power house. Although this seems rather unlikely, on account of the fact that the tracks on the bridge proper are laid on the wooden flooring and are hence fairly well insulated, still there remains an uncertainty about the currents from the New York approach in which the tracks are laid in the ordinary pavement. Large currents will necessarily return from these tracks to the power house, owing to the heavy grade and the great number of cars which will pass over it, and current tending to return by the ground will naturally seek the continuous steel cables of the bridge, passing into them at their New York anchorage and out from them at their Brooklyn anchorage and thence to the source of supply. Just what is the resistance of concrete, such as these anchorages are buried in, to the passage of currents and just what electrolytic action takes place when currents pass between metal and concrete is apparently not very well known, but the question should certainly be thoroughly settled before a simple ground return is allowed on the bridge, owing to the enormous risk which the slightest uncertainty would involve.

The trains now running over the bridge, although hauled by cable for the major part of the distance, are switched at the termini and lighted and even propelled at night by electric power supplied from the third rail and returned through the service rails. These rails, however, all being on wooden sleepers are probably sufficiently well insulated from the bridge structure to prevent any serious leakage. Some such system of third rail or extra conductor, either overhead or to one side of the car, might be adopted for the bridge section of the Brooklyn trolley system, but would necessitate the equipment of an enormous number of cars with apparatus only used for a short part of their trip. A better plan might be to maintain, by extraneous means, the difference of potential between the ground at the two ends of the bridge at zero, a further advantage of this plan being the probability that there is already a difference of potential sufficient for slow electrolytic action, even with no electric power on the bridge itself. The question seems to be one that has not been brought up before, and it may be worth while to look into the matter in case of other bridges.

THE INDEX TO THE ELECTRICAL WORLD, VOLUME XXX.

The Index of Volume XXX. of THE ELECTRICAL WORLD will appear as a supplement with the issue of January 8.



GREATER NEW YORK AND

ON January 1, 1898, a score of cities, towns and villages, ranging in population from a few hundreds to two millions, became consolidated into one city of New York. With an area of 360 square miles and some 3,300,000 people the American metropolis will be second in size only to London of all the cities of the world. In course of time New York may even surpass London, as the growth of the former is at the rate of 315 per day, while London's increase is but 230. The Greater New York does not include, as do other large cities, all of the district over which the immediate suburbs are scattered, because of the State line running down the Hudson River preventing the incorporation of an enormous population on the New Jersey side of the river. Manhattan Island, the original city, has become a small part of the Greater New York in point of area. Of the 360 square miles of the whole city, Manhattan Island covers only about 26 square miles. Its length is but 13 miles, while that of the whole city is 35 miles. The new territory incorporated is mainly on Long Island, including Brooklyn and the districts toward the ocean, inclusive of Coney Island and Queens County, which takes in Flushing and Jamaica down to Rockaway Beach. Staten Island, with its 59 square miles of territory and its scattered population, also extends the city far towards the south.

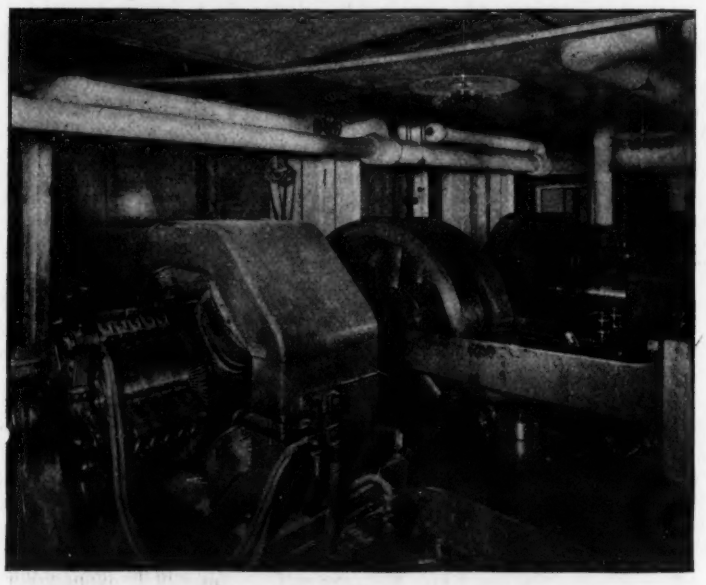
In this great city there is now taking place a most marvelous development of all the electrical arts. The figures of the present and intended applications of electricity are most surprising. The city is so large and its districts are so sharply differentiated into those of offices, stores, residences, etc., that the transportation problems are truly colossal. In the narrow tip at the lower end of Manhattan Island, grouped in less than one square mile, are the towering office buildings shown in the accompanying illustrations. To these and the district immediately adjoining them must be brought every morning and taken away every night something over one million people. The greatest factor in this transportation problem is the Manhattan Elevated, which carries some 600,000 passengers daily on its overhead lines. In the borough of Brooklyn there are two other elevated systems, each with an enormous traffic. The total mileage of elevated track of these three systems is some 90 miles double track. These lines, while all operated by steam at the present time, will undoubtedly adopt electric traction in the course of the next few years. The Brooklyn lines are at the present considering the problem in connection with their proposed extension over the Brooklyn Bridge. This bridge, which was finished in 1883, and which was apparently ample then for the traffic for many years to come, has already become much overcrowded. During the past year the bridge has carried over forty million passengers in the bridge trains, the equipment having been greatly improved by the adoption of double loading and unloading platforms at the terminal stations, gauntleted tracks and electric motors on the cars themselves for switching operations in the termini, the power on the bridge proper being cable. Already the surface trolley roads of Brooklyn are building tracks for their cars on the roadways of the bridge, and the Brooklyn elevated lines are planning for their extension in the same direction. A new bridge is being built about one mile above the existing bridge, with many tracks for electric surface and elevated cars, and work has been started on the double-track tunnel under the same river for the extension of the Long Island Railroad system into New York City, the traction on which is to be electrical. Several other bridges and tunnels have been proposed between New York and Brooklyn, but only one—a bridge at Sixty-fourth street—has been gotten under way. Across the North, or Hudson River, between New York and New Jersey, all traffic is still carried on the

TRACK CONSTRUCTION OF METROPOLITAN STREET RAILWAY COMPANY.

ferries. Many tunnels and bridges have also been proposed for this river, and one tunnel has been driven more than half way across the river, the work on it having ceased several years ago owing to financial difficulties. That this river will be crossed by tracks either below or above in the next two years no one doubts, and here, as well as across the East River, will be another great application of electric traction. On the Island of Manhattan proper the great movement of traffic is north and south, the crosstown distances being short and easily covered on foot.

The Manhattan Elevated, with its unsightly structure and antiquated methods, has long monopolized this traffic, although of late the splendid systems of surface traction built by the Metropolitan

Street Railway Company have cut deeply into the business of the elevated. Of these street systems the Broadway cable road is the most famous, but the company has during the last year changed its attitude, and decided to install in future nothing but underground conduit open slot electric systems. Of these many miles have been installed in a most thorough manner during the last few months, and have begun a service which is an eye-opener to people accustomed to ordinary street railway methods. The magnitude of the company's intended extensions in this direction is shown by the power stations planned. Two stations are now almost completed, aggregating 10,000 horse-power of electric generating machinery. These stations are only temporary, and are intended only to carry the load until the construction of the new 70,000-hp central station is finished, work on this having been already begun, and the time of construction being estimated at about two years. This great station



GENERATING UNITS FOR A TWENTY-FIVE-STORY BUILDING.

will distribute high pressure multiphase alternating current to substations located about the city, where it will be transformed to such a current as may be found most suitable for the operation of the cars themselves when the time for its use arrives. This company controls almost the entire surface mileage of street cars on Manhattan Island, the aggregate length of tracks being 230 miles. The number of paying passengers on this system during the year has reached amost 200,000,000, and the rapid extension of the electric service will greatly increase this during the next few years. Even this combination of elevated and surface lines does not begin to satisfy the need of transportation facilities lengthwise of the narrow island, and for many years the city has been struggling against the vested rival interest to construct a rapid transit underground system for the operation of high speed electrical express trains, in a subway following closely the main surface arteries of trade. The legal preliminaries of this intended line have not yet been cleared up, and there is no way of telling how long its construction will be further delayed. Even if the growth of the city should stop abruptly at the present time, however, this subway would be an almost imperative necessity, and, considering not only the rapid growth of the city, but the increase in the rate of that growth, and the further increase in the per capita intramural travel of the population, this subway will not only be needed, but further subways and tunnels must certainly be constructed from time to time as the demand increases.

In the borough of Brooklyn there are two electric street railway systems which have become famous owing to their size and the congested traffic which they handle.

Of these the Brooklyn Heights Railroad Company is the greater. Its system comprises some 274 miles of electric roads, single track measurement, on which are operated 1362 motor cars and 900 trailers. The system is supplied with power from three generating stations, of which the Kent avenue is famous for the size of its generoting units. Two units of 1500 kw capacity each are now being installed in this station. The total rated capacity of the three stations is 13,800 kilowatts, and the coal consumed per annum is about 75,000 tons.

The Nassau Electric Railroad Company operates also in Brooklyn a system with some 126 miles of track, and supplied with current by a station with over 5000 horse-power available. The other electrical roads operating in the greater city are the New York & Queens County, the lines of which run between Long Island City, Astoria, Steinway and Flushing, with 30 miles of double track and 225 cars.

On Staten Island there are two systems, one that of the New York & Staten Island Electric Company, with some 30 miles of track and 70 motor cars; the other that of the Staten Island Midland Railroad Company, with some 28 miles of track and 73 electric cars.

Of the electric lighting systems of Greater New York the greatest is that of the Edison Electric Illuminating Company, of New York. This company operates an extensive system of three-wire direct current underground feeders and mains, all closely intermeshed and interlinked, with five steam-driven generating stations, one storage battery sub-station and one motor generator sub-station. The greatest of these is the Duane street station, with a battery of Babcock & Wilcox boilers rated at 5000 horse-power, an equipment of vertical multiple expansion marine type engines rated at a total of 11,800 horse-power, and direct coupled to Edison multipolar, low-speed smooth-body dynamos, capable of delivering 57,000 amperes at 125 volts. The aggregate steam generating capacity of all the stations on this system is 22,550 horse-power, capable of generating 15,720 kilowatts, or 113,800 amperes, besides the capacity of the storage batteries, which, at a three hour discharge rate, are capable of giving 4666 amperes. The service of this company is divided between two classes of customers, those with what is called full central station service and those who only take so-called "breakdown" or limited service, the latter having isolated plant generating equipments of

THE HIGH-BUILDING DISTRICT OF MANHATTAN.

their own with connections such that they may shut down their own plants and take current from the company's mains, either in case of emergency or at times of light load. The following table shows the magnitude of this service.

SUMMARY OF CUSTOMERS' INSTALLATIONS, DECEMBER 11, 1897.

Customers supplied with full Central Station service:

No. of customers			7234
No. of incandescent lamps (equivalent 16 cp.)			348,897
No. of arc lamps:	Open Arc Lamps.	Enc. Arc Lamps.	Total.
Commercial	2628	1508	4136
City lighting	372	234	606
	3000	1742	4742
Horse-power of motors			18,962
Total installations connected (equivalent 16 cp.)			680,747

Consumers with "breakdown" or limited service:

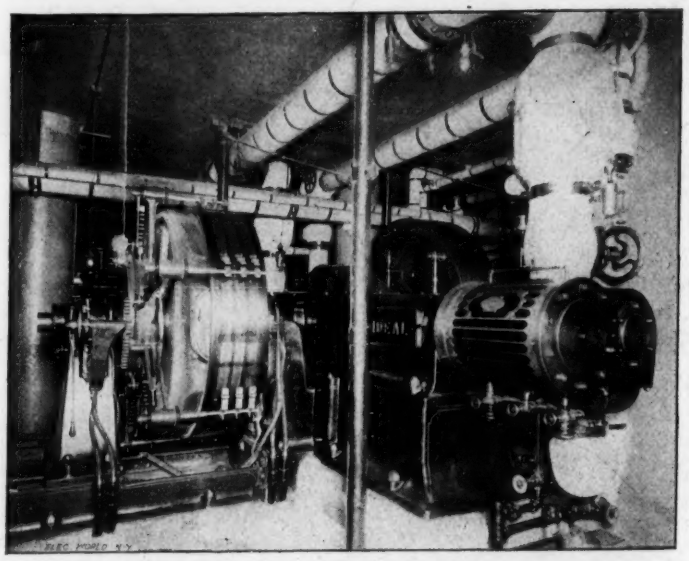
No. of customers	76	
No. of incandescent lamps (equivalent 16 cp.)	60,117	
No. of arc lamps (equivalent 8 amp.)	698	
Horse-power of motors	962	
Total installations connected (equivalent 16 cp.)		81,527

Total installation connected to customers' mains:

No. of customers	7310	
No. of incandescent lamps (equivalent 16 cp.)	409,014	
No. of arc lamps	5 440	
Horse-power of motors	19,927	
Grand total of all installations connected to company's mains (16 cp. equivalents)		762,274

The Edison Company is peculiar in that it makes public with perfect frankness its entire schedule of rates and charges. The company's charges for service are based on the price of 1 cent per 16-cp lamp hour, including the renewal of lamps. Discounts for quantity are given, ranging from 5 per cent. for $100 to 40 per cent. for $1000 or over of gross bills monthly. For long hour use an additional discount is given to customers consuming 5000 or more lamp hours monthly of from 5 per cent. for 50 hours to 20 per cent. for 125 hours monthly average use of each 16-cp lamp or equivalent installed. For arc lighting the base price is 10 cents per 8 ampere lamp hour, with discounts for quantity and for long hour use, the mimimum charge being $3 per lamp per month. Power service is supplied at the base price of 10 cents per kw hour, with discounts up to 60 per cent. for 10,000-hp hours per month. The wholesale price on the kilowatt basis is made to consumers using not less than 2500 kw hours per month for ten months in the year for any and all purposes, with discounts for quantity and long hour use. Storage bateries are supplied with current, when it is taken outside of maximum load hours in large quantities, at 6 cents per kw hour, with discounts up to 2 cents on 10,000 kw hours per month, making the value of this cheapest rate of the company 4 cents per kw hour.

This system of the Edison Company is of considerable historic interest, as current was first turned on to the mains from the now historic Edison "Jumbo" dynamos in 1882 and has been kept on continuously ever since, with the exception of a few hours after the burning of the original Pearl street station. The stations are built on the peculiar design worked out by the Edison Company for the greatest economy of ground space in expensive districts. The engines are direct coupled to dynamos placed on the lowest level; above them are the shops, ash hoists, etc.; above them again the water-tube boilers, and still higher up the coal bins with suitable chutes, conveyors, hoists, etc., for the proper manipulation of everything with minimum labor. The largest machines used in these stations are the 2500-hp quadruple expansion engines built by the Southwark Foundry & Machine Company, of Philadelphia, each direct coupled to two 800-kw generators. The engines are two-crank, four-cylinder combinations, with the larger cylinders placed above. The valves are controlled by a radial valve gear, the high-pressure cylinders being equipped with four valves, and the steam

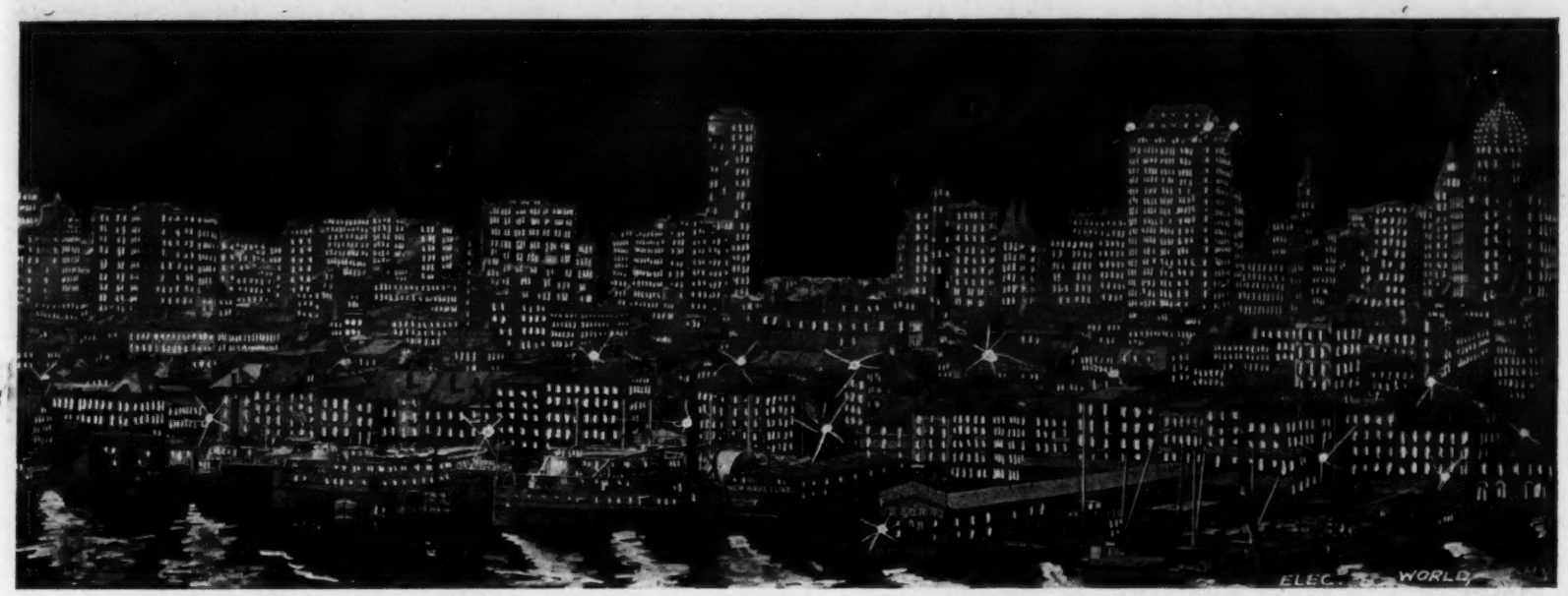


GENERATING UNIT IN THE COMMERCIAL CABLE BUILDING.

valves being controlled by a Porter governor. The generators of these large machines are of the smooth body type, with the radial armature connectors from the inside to the outside winding at one end of the armature, forming an annular disc-shaped commutator on which the brushes bear. The machines are controlled and their output measured by instruments arranged on the Van Vleck edgewise system.

The rest of the public lighting of Manhattan Island is carried by high tension service, including alternating and series arc systems.

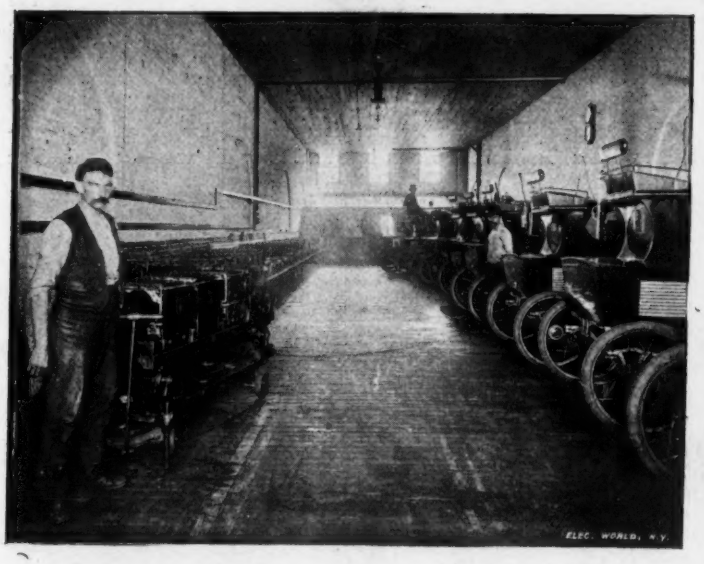
The Manhattan Electric Light Company, which is controlled by the Edison Company, operates two stations, with an aggregate generating capacity of over 3000 kilowatts, the load consisting of 40,000 incandescent lamps, 2500 arc lamps, and alternating motors aggregating 250-kw capacity. The alternating apparatus is of the Stanley inductor type, belt-driven, with a frequency of 60 cycles per second.



AS SEEN BY NIGHT FROM THE BRIDGE.

The greater part of the arcs are supplied by Brush multicircuit machines.

The United Electric Light & Power Company operates several stations, the main load being carried by Westinghouse two-phase double field ring direct-coupled alternators, of what are known as the World's Fair type. Several high tension systems have stations scattered about over the city. In Brooklyn also the Brooklyn Edison Company operates several stations, all interconnected on underground low tension direct current mains, with an aggregate generating capacity of 10,000 kilowatts, supplying over 100,000 incandescent lamps and over 6000 arc lamps and 4800 horse-power in motor load, the conduits for this distribution aggregating 130 miles of three-wire conductors. This system is now being equipped with a



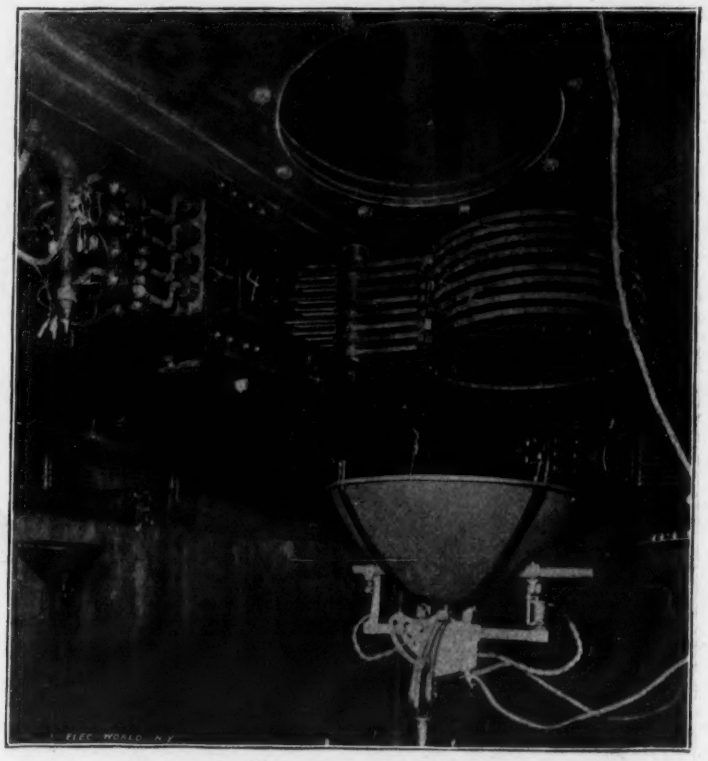
STABLES FOR ELECTRIC CABS, SHOWING ACCUMULATORS.

mammoth generating station on the water front, quite distant from the centre of distribution, but admirably situated for low running expenses. This plant is being equipped with large direct-coupled three-phase generators of 1500-kw capacity each. Current will be transmitted from this system at 6000 volts to stationary and rotary transformers in the present station, and hence distributed over the existing mains as direct current.

The Municipal Electric Light Company also operates two stations in Brooklyn, with a load of 30,000 incandescent and 100 arc lamps supplied by alternating current, besides 2600 arc lamps on the series system.

Staten Island is lighted from the stations of the New York & Staten Island Electric Company. This company is now building a new station at Livingston, which when in running order will carry the whole lighting load of the island, as well as a large electric railway system. Sixteen thousand incandescent lamps, 300 arc lamps and a small motor load are supplied over 120 miles of pole line, stretching over the whole island, which is some 15 miles in length. Stanley two-phase direct-coupled alternators and multicircuit Brush machines are used. For the supply of the distant end of the island 5000 volts will eventually be sent out from step-up transformers, the nearer districts being fed from the machines direct at 2000 volts.

One of the most interesting of the electrical features is the number and magnitude of the isolated plants mostly in use for the lighting and power service of the towering office buildings of the busi-



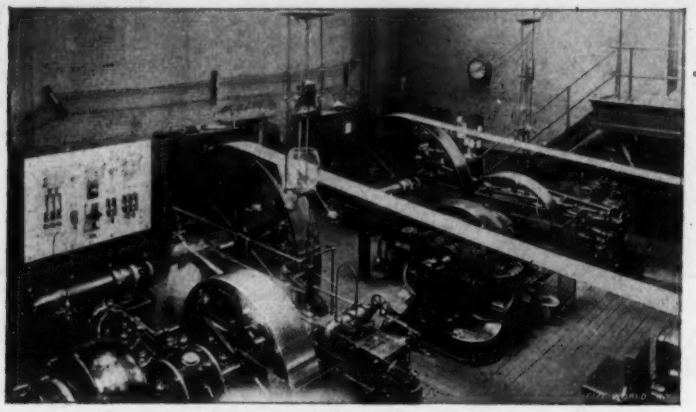
UNDER THE ELECTRIC FOUNTAIN, BROOKLYN.

ness district. These office buildings, on extremely valuable real estate, are so economical of space that in their many stories the largest of them provide for a population of many thousands, and the consumption of current in one of them for lighting purposes on dark winter afternoons is as great as that in may a fair-sized city, while those built during the last few years have almost universally adopted electric power for the elevator equipments, which are naturally very extensive in such high and densely populated structures. The total number of isolated plants on Manhattan Island proper, according to the statistics of the Underwriters Association, is 775,

with an aggregate generating capacity of 46,000 kilowatts, supplying 475,000 incandescent lights, about 3000 arc lights, and 11,000 horse-power for motors. The number of these isolated plants of different capacities is rather interesting, and is shown in the following table:

125	plants	ranging	from	½	to	10 kilowatts.
275	"	"	"	10	"	50 "
250	"	"	"	50	"	200 "
125	"	"	"	200	"	1000 "

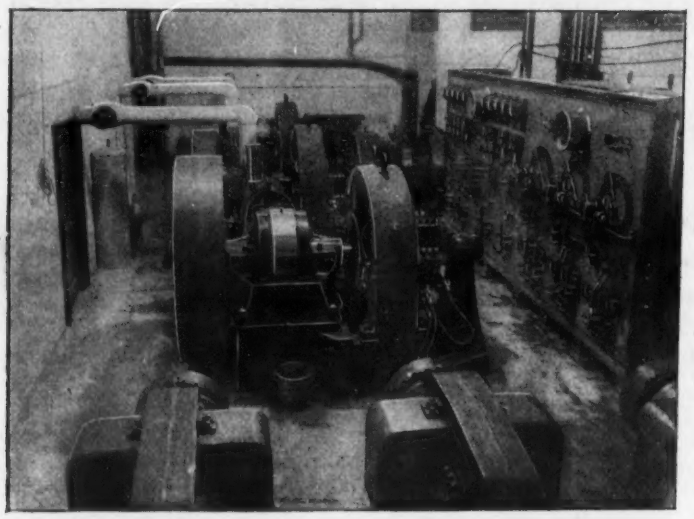
The largest of these plants is that of the Astoria Hotel, described



Lighting Plant for the Brooklyn Bridge.

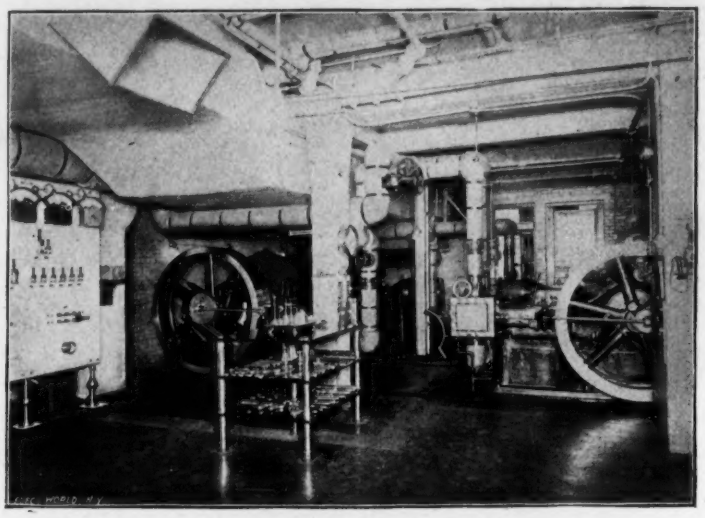
in The Electrical World of December 25, 1897, with 1200-kw generating apparatus at 110 volts, besides a large storage battery. This plant is remarkable in the magnitude of its various details, there being, for example, over twenty electric elevators and a large number of motors for all sorts of other purposes. The second largest plant is that of the Siegel-Cooper department store. Many other large plants are in use for the various theatres, office buildings, factories and large store buildings. These plants, while exhibiting a considerable diversity of machinery among those built some years since, have now come to an almost universally accepted standard. This consists of single cylinder high speed single valve horizontal engines direct coupled to generators of either 110 or 220 volts pressure.

Many such plants are provided with what is called a "breakdown" connection with the direct-current mains of the Edison systems.



The Engine Room of the New York Telephone Building.

In this case either the plant must be a 220-volt two-wire system or a 220-volt three-wire system, capable of being thrown over at will to a two-wire system for the isolated dynamo. The prohibition of large sizes of 110-volt motors on the Edison service makes it necessary to make all the isolated plants with heavy motor service with 220 volts pressure; and to avoid the necessity of any balancing devices the most recent plants are now being built with 220-volt incandescent lamps and enclosed arcs, arranged two in series, for use between the same mains. This provides a very simple and effective system of supply and reduces the internal losses in the building to a negligible amount, even with a remarkably small amount of copper in the distributing system. The majority of such plants use the exhaust steam from the engines for heating purposes at least one-half of the year, and that half of the year fortunately is simultaneous with the heaviest loads on the elcetric system, so that steam economy is a small factor, as any increased economy of the engines simply extracts that much



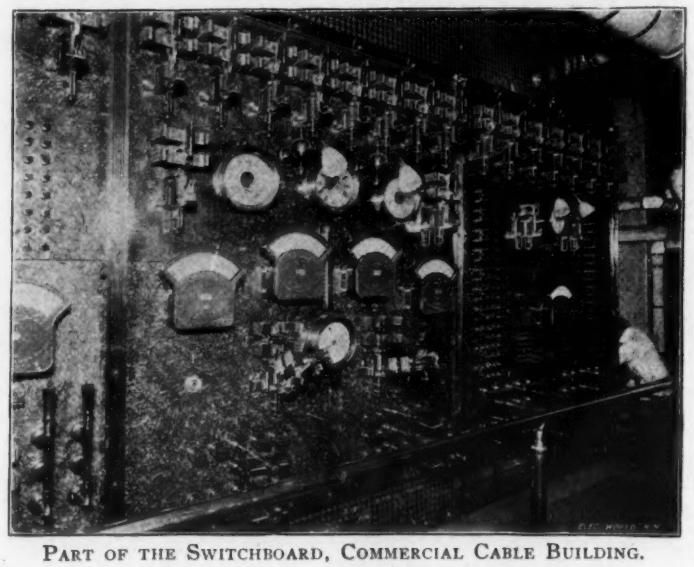
A Typical Cellar Engine Room.

more heat from the steam passing through the engines and necessitates as a rule the use of that much more live steam in the heating system.

Beside the electric lighting and street railway systems of this city there are telegraph and telephone systems of surprising magnitude.

The telephone service of the Greater New York is handled by two corporations, the New York Telephone Company, operating in the Borough of Manhattan and the Borough of the Bronx, and the New York and New Jersey Telephone Company, operating in the Boroughs of Brooklyn, Queens and Richmond. Both of these companies are licensees of the American Bell Telephone Company.

The New York Telephone Company has connected to its thirteen central offices some 25,000 stations. The largest switchboard is that of the Cortlandt Exchange, which is equipped for about 5500 subscribers' lines, besides the trunk line and long distance sections. The



Part of the Switchboard, Commercial Cable Building.

length of conductors, which are all copper metallic circuits, is over 50,000 miles single wire measurement of underground lines, besides some 6400 miles of overhead wires.

The large manufacturing and commercial hoses in the city have private branch exchanges connected by trunk lines to the main exchanges of the telephone system. Of these private branch systems there are about 200 connected with the New York Telephone Company's service. The total number of employees connected with the service of this company alone is about 1800, the annual number of

calls on the lines of the system being estimated at approximately 41,600,000. The rates charged for service in the largest city of this country are of interest. The contracts are based on the amount of service rendered, this being considered the most equitable basis, both for the company and the subscribers.

The minimum rate is $90 per year, for which a direct line and full long distance equipment is put in, and 600 local messages per annum are allowed without extra charge, the messages over and above that number being charged at 10 cents each.

The contracts may be signed for more and more messages up to 4500 for a single instrument, at annual rates rising to $240 for the 4500 messages. When more than this number of messages is used the subscriber is advised to put in two instruments in order to prevent overcrowding of the wire, charge for the extra instrument being $60 per annum.

The headquarters of the Western Union Telegraph Company and the Postal Telegraph Company are both situated in New York City, each being installed in a large office building, largely occupied by its own offices and operating rooms.

The Postal Telegraph Cable Company operates a total of 135 offices, scattered through the Greater New York, interconnected by some 2500 miles of wire in subways, and 100 miles of conductors in submarine cables across the various rivers.

SWITCHBOARD IN AN OFFICE BUILDING ISOLATED PLANT.

Mr. Depew's Narrow Escape.

The death of Gardiner G. Hubbard is alleged to have brought forth an interesting reminiscent story from Chauncey M. Depew. It was a tale with a moral, and was as follows:

"That brings back to me an incident in my early life which, viewed in the light of latter-day events, goes to show what a wonderful 'scheme of things entire' this world is, and how marvelously things balance in the end. Thirty years ago I was counsel for the Harlem road, and Gardiner G. Hubbard was railway mail inspector. In the course of our official duties we were thrown frequently into contact, and came to know each other well. I liked him, and he seemed to like me. We grew more and more confidential, until one day Hubbard came into my office, and leaning against my desk said:

" 'Depew, I have a son-in-law. He is a bright young fellow named Bell. He is a student, and not very practical in his ideas. He has invented a talking telegraph. It is a wonderful sort of an arrangement. I think it has wonderful possibilities in it for short communication for use in villages and other places, and will save a great deal in messenger-boys fees, and so on. I don't think it will ever be of much use for long-distance messages, but is seems as if it might have a field of its own.'

"In those days Hubbard had no money, and I had only a little. He suggested to me that I take an interest in the invention, and made a proposition that I advance $10,000, for which he would give a sixth interest in the patent. I said I would think it over. The next day I went downtown and saw William Orton, who was at that time president of the Western Union Telegraph Company. I laid the matter before him fully. He said to me:

" 'Depew, you haven't got much money, and as a friend I don't want to see you lose what you have got. That invention is practically worthless. It will never amount to anything. If it should, however, we own prior rights upon the idea, of which Bell's patents are simply an infringement. Don't throw away your money.'

"I took his advice, and now I am in a position to reflect. What would have been the result? I would be to-day, or my estate would be, worth something like $30,000,000. I say my estate, for in the event of my having secured an interest in that tremendously successful company I do not think that I should be alive to-day. Why? Because I would have suddenly grown rich. I would have had, aside from my tremendous holding of stock, an enormous revenue that it would have exhausted me to spend. There would have been no incentive for me to engage in healthy labor and in intellectual work such as I have been compelled to keep at in order to make my way in the world. I attribute my life and my health to continued and healthful labor. Not overwork, or underwork, but just a natural allotment and a fair share. Had I received all this income and sudden wealth there would have been no incentive to work; I should have deteriorated and would to-day perhaps be dead, and forgotten as one in life who was practically unknown. The papers would have chronicled the death of a tremendously wealthy holder of telephone stock, and there it would have ended. Things certainly move in a marvelous orbit, and the fine adjustment of lights and shadows, aims, ambitions and human passions is always marvelously well balanced."

A Gas Engine Electric Light Station.

The electric light station of the Midland Railway Company, at Leicester, England, has been in successful operation for three years using gas engines giving a total of 460 horse-power to drive arc and incandescent light generators. Gas is made on the premises by the Dowson process. So far the operation of the plant is reported to be very satisfactory, the cost for repairs having been only nominal.

A Review of American Electrical Progress During the Year 1897.

THE twelve months just passed have been distinguished by no very startling or radical innovations or discoveries in the electrical field, but rather marked by a steady advance along all lines. Applications of electrical power and the general utilizations of this agency have multiplied, and a gratifying enlargement of the capital invested, both in manufacturing electrical apparatus and in the generation of current, may be noted.

Prominent among the purely scientific discoveries of the year is that of Dr. Zeeman concerning the remarkable and beautiful phenomenon of the widening of the spectral lines of incandescent gases when the source of luminosity is in a strong magnetic field. Knowledge of Röntgen rays, cathode rays, and the other phenomena of vacuum tubes has increased somewhat, and the power and convenience of instruments for the generation of X-rays has been greatly bettered. The induction coil and static influence machine have both undergone great improvement as the result of the wide interest in vaccum tube phenomena and the demand for instruments of higher power.

In the generation of electricity by the direct consumption of carbon little or no advance seems to have been made. The parade of newspaper announcements heralding the advent of direct heat-generation methods has passed, and the subject seems, for the moment, to have ceased to attract investigators.

In practical engineering there have been several marked features of advance. The long distance transmission of water power has been the field for many interesting developments, and the colossal installations erected during the year have exhibited the highest class of engineering skill and not infrequently of capitalistic daring. The increasing use of multiphase currents and the continual improvement in machinery for their generation and utilization has shown the direction of the evolution of central station and power-transmission engineering, while their application to railway work is strongly foreshadowed.

In electric traction increasing attention has been given to the equipment of heavy railways, principally for suburban traffic and of those working under exceptional conditions, such as elevated roads. The experiments of the New York, New Haven and Hartford Railway Company, near Hartford, have been an encouragement to the railway companies, while the equipment of roads intermediate in class between the ordinary city trolley line and the heavy railroad has progressed continuously. The adoption of an open conduit system by the street railways of New York City and the success which has attended their opening for traffic are important factors of the year's advance in electric traction.

The electric automobile has taken its place as a commercial and practical machine, and electric cabs and vehicles no longer attract attention in the streets of New York.

In electric lighting the principal advances have been in the increasing use of high voltage lamps and the substitution of rotary transformer sub-station systems for the multi-station low-pressure installations which have for many years illuminated our principal cities. In many new installations lamps for 220 volts or even higher pressures have come into use, while numerous installations have changed over from the old standard pressure of 110 volts to the new.

The enclosed arc lamp has increased its applications prodigiously, and seems to bid fair to displace the open arc form in many places. It has of late been used, burning on constant-potential circuits, for street lighting with excellent results and it is confidently expected that the alternating current types of such lamps, which have been perfected during the year, will soon be as widely used as those for direct current.

In telephony the advance has been confined to details of exchange systems rather than to radical improvements of apparatus. The independent companies have grown in strength, and their association formed during the past summer promises to play an important part in telephone affairs in the future.

Telegraphy has not greatly advanced. There are promising indications that processes of machine telegraphy will shortly be brought to greater perfection, and that they will then largely supersede the present manual systems. Some new submarine cables have been laid and plans formulated for a Pacific cable, which will be the last link in the electric girdle of the earth.

The electric elevator has taken its place as the standard machine, having been almost universally installed in new buildings, and in many cases taking the place of hydraulic elevators.

In other applications the great adaptability of the electric motor has ben prominently shown. It is coming to be used more and more for the direct driving of many kinds of machinery, notably printing presses and machine tools, and the manifold advantages of electric power transmission over the time-honored method of belts and shafting have become so well understood that few large new factory installations are considered complete without an electrical system of machine driving.

The accumulator has not materially changed during the year, few new types having been exploited, but its use has been greatly extended, both for electric light and railway purposes. In this respect American engineering has been somewhat backward, the merits of the accumulator having received a substantial recognition in Europe for several years. There has been but one revival of an attempt to operate accumulator cars, it being generally considered that past experience with them has promised little to future experimenters.

The alternating current motor has been greatly developed. Many experimenters and designers are diligently at work on the problems connected with their use, especially in railway work—a most promising field for them. New methods of control and operation have been devised, many of them of the greatest originality. The general expansion of alternating current work in all directions is well shown by the interest evinced on all sides in polyphase motors.

Transformers of the stationary type have been made larger and better than ever before, and their internal losses reduced by careful proportioning and design.

The general trend of discussion has brought out a few noteworthy indications of the tendency of future progress. The perfection of alternating current apparatus has made much of the direct-current machinery now in operation old fashioned and the tendency in this direction seems to be for the superseding of the older forms by the more flexible and satisfactory multiphase systems. The rotary converter has been brought to great perfection and in such installations provides the direct current where this is necessary.

Looking at the future of the electric railway it is seen that all indications point to the suppression of the steam locomotive for suburban and interurban work in favor of the electric train. Already several railways having large suburban systems are making experiments and preparing for the inevitable change in motive power.

The experiments in electric transmission between the engine and running gear of locomotives should not be overlooked, and the appearance of some promising hybrid types of gas engine electric locomotives is also noteworthy.

Certain long promised improvements in other departments seem to be progressing slowly. "Cold light" has not yet become a commercial possibility, though some very interesting public experiments have been made. The limits of long distance power transmission seem to be now set at about 80 miles—and this in a dry climate. The telephone repeater remains as a source of inspiration for determined, but so far unsuccessful, inventors.

Perhaps the most popular demonstrations during the year have been those made by the advocates of wireless telegraphy, largely owing to the prominence given to the well-known Hertz waves by Mr. Marconi. This seems to have, in a measure, captivated public fancy, but so far no very practical results have been attained, nor has the advance been commensurate with the interest it has elicited.

The steam turbine as a possible and probable factor in the development of the electric arts deserves notice as the most promising method of developing the motive power of steam at present known.

It may be said, in conclusion, that the progress of the electric arts in America during 1897 has been very gratifying. Electrical engineering has advanced beyond the stage when revolutionary departures are the rule, and has reached the level of successful adaptation to the demands of necessity. Its growth and extension therefore must now be marked rather by the steady betterment of its means and methods, the gradual enlargement of its field of labor, the deeper identification with the advance of civilization, than by brilliant and revolutionary change. Here, at the beginning of a new year, it is pleasant to look back and see that in no single department of the vast field of the electric arts has there been any retrogression, but in all that sure and steady improvement that is the sign of maturity and full development.

Electrical Industry in France During 1897.

BY PROFESSOR J. BLONDIN.

N the year which has just come to an end no invention or new application of very great importance has appeared in any of the various departments of the domain of electricity. Nevertheless, it appears that electricians would scarcely be wise to complain of the results accomplished during the twelve months past, for real advance has been made in all branches of electricity, and particularly in those of traction and electro-chemistry.

Electric traction is the one field which has captured the attention of electricians and of the French public. Introduced some years ago by the powerful company organized in France by the General Electric Company—the French Thomson-Houston Company—traction by the overhead trolley was not slow in gaining public favor, and, by the beginning of 1897, several towns in the provinces possessed installations of electric tramways, of which the total development permitted France to be classed in the second rank of European nations in statistical tables relative to electric traction. This year, thanks to the activity of the Thomson-Houston Company, and to the creation of a powerful financial association, the Compagnie Générale de Traction, and to the efforts of several other concerns, notably the Compagnie de Fives-Lille, progress has been more rapid. Cities already provided with installations of electric tramways have seen these develop and grow, and a large number of others have commenced the inauguration of this new method of traction. Others yet more numerous are about to begin such installations. The results are most encouraging, and without being a prophet I can predict that before long electric traction by overhead trolley will have replaced horse traction where that still exists, and will also find its place in many provincial cities where animal traction has not yet been able to establish itself on account of the high cost of its operation.

But if the provincial cities have already profited by the incontestable advantages of electric traction, it is far from being thus the case in Paris, in spite of the public clamor. There two causes of a different kind stop the efforts of the electricians. In the first place, the concessions accorded to the powerful Compagnie Générale des Omnibus have left for the companies which are attempting to make electrical installations only a choice between a small number of minor and insignificant routes; and, consequently, but little business and no opportunities for profit. In the second place, the overhead trolley has neither the favor of the public nor that of the municipal administration. The first difficulty is of the kind which can only be overcome by time, that is by waiting for the expiration of the concession accorded to the omnibus company. Unfortunately, this concession will not expire for about fifteen years. As to the second, the repugnance of the public and the administration for the overhead trolley is without doubt exaggerated, for while it is true that the overhead conductors would have a deplorable æsthetic effect in the fine quarters, concerning which Paris so justly prides herself, there are many streets where it would be perfectly acceptable.

However, these two difficulties exist, and the first aim of the electricians is to surmount them. With this end in view, efforts have been numerous. The Thomson-Houston Company, for the purpose of allowing the Parisians to understand and easily appreciate the advantages of electric traction, has for the last two years maintained an overhead installation some kilometres distant from Paris, between Le Raincy and Montfermeil. On its part the General Traction Company submitted at the beginning of the year a project for an important installation to serve all Paris and the outlying districts by means of accumulator cars in the interior of the city and the overhead trolley on the exterior. MM. Claret and Vuilleumier installed last year their closed conduit surface contact electric tramway in one of the finest avenues of the city. During the same year the Heilmann Company inaugurated, on several lines, electric traction by rapid charge accumulators, thus following the way opened some years ago by the Société Pour le Travail Electrique des Métaux. Finally, unable to do any better, several companies proposed to the omnibus company to install electric traction upon its system. It is thus possible to say that if the Parisians are yet served by a mode of traction which is slow and most uncomfortable it is certainly not the fault of the electricians.

Elsewhere these numerous efforts have not remained without result. If the recent determination of the General Council of the Department of the Seine is entirely realized, fourteen lines of electric traction will shortly be constructed in the suburbs of Paris, and as the concessionnaires of these lines are able to control lines penetrating into Paris, on account of the fact that they are found to be the principal feeders for the Northern Tramway Company, the Southern Tramway Company and the Claret-Veilleumier Company, the Parisians will soon have an important system of electric tramways penetrating into the heart of the city. Certainly the solution of the problem will not be perfect on account of the impossibility of connecting the various lines across Paris, but a great step will have been effected. As to the system adopted it is extremely probable and almost certain that it will be the mixed system already used by some continental cities, particularly Hanover—the overhead trolley outside the city and accumulators inside.

To further understand the diverse conditions, and on account of its importance from the point of view of the development of electric traction in France, something must be said here about the Métropolitain. This year the Municipal Council of Paris pronounced itself strongly in favor of the construction of a metropolitan railway straight across Paris operated by electric traction. The employment of electricity for the working of this railway is to-day accepted by everybody as a necessary consequence of the foreseen volume of traffic, and no one has so far raised any objections. Unfortunately it is not the same with the construction of the straight right of way, which has encountered many adversaries, among which are numbered the Government and the large railway companies. This solution does not permit of the union of the metropolitan line with the larger railways, particularly with the belt line road which should be considered as a sort of feeder for the future metropolitan line. Under all these conditions it looks as if it would be imprudent to pronounce upon the date when Paris will possess her metropolitan line. To conclude the subject of electric traction as applied to urban transportation, the electric railway which is about to be constructed to serve the various parts of the Exposition of 1900 should be mentioned.

The application of electricity to traction on heavy railways has been the object of important experiments undertaken by the Société des Etablissements Heilmann. The locomotive, of which a description was published in THE ELECTRICAL WORLD during the past year, has been on trial now for two months on the tracks of the Compagnie des Chemins de Fer de l'Ouest, and the satisfactory results obtained lead to the hope that in a little while, or as soon as the second locomotive now under construction is ready, a regular electric service will be inaugurated. The same company has undertaken at this time a series of tests of a different kind on a line about a mile long, also belonging to the Western Railway system, at St. Germain. There traction is effected by the ordinary electric locomotive to which current is fed by an insulated rail, this being the system ordinarily known as the third rail. These experiments are made with a view to the application of electric traction on the belt line, the suburban and the metropolitan lines.

Electro-chemistry is, as was remarked at the beginning, that application of electricity which has made during the year the greatest progress, with the exception of traction. But in this branch of industry nearly everything is kept secret, and while it is easy to see that a new factory has been installed, it is almost impossible to learn what is done inside of it. It must not be forgotten that during the year new factories, all of them operated by turbine water wheels, have been erected for the manufacture of calcium carbide, of electrolytic sodium by the Hulin process, of bleaching hypochlorites, chlorates and even of ozone. I regret that I am not able longer to tarry upon this interesting application of electricity, because it has a considerable importance in the development of the riches of France, and permits the utilization of motive power of numerous water falls, up to this time unemployed. A singular demonstration of this is the high prices which are to-day asked for any kind of water fall, things which have had no value until a few years ago.

Passing now to other applications of electrical energy there is much progress to record, though less important than the preceding matters. Long distance transmission of power has benefited considerably by the extension of the utilization of water falls for the electro-chemical industries, and in the east of France, in the Alpine

region, numerous installations have been put in or are projected. Work on the Jonage Canal, which will permit the utilization by numerous workshops in the regions of Lyons of about 10,000 horsepower withdrawn from the Rhone, is advancing rapidly, and it is probable that the year 1898 will not pass without seeing the completion of these works. Many electricians now believe in the commercial possibility of transmitting the energy of water falls to distances of 100 kilometres, and hope to find in agricultural operations considerable opportunity for the utilization of this energy. Some experiments made recently in the application of electrical power to agriculture appearing to augur well for this new departure.

The electrical transmission of power in factories and shops counts to-day numberless partisans. Many new factories have adopted this mode of transmission, and the older concerns are coming little by little to the point where the need of changing their methods begins to make itself felt. The advantages of electrical transmission are now no longer a subject for discussion, and it is easy to predict that this branch of electrical industry will soon take a considerable forward movement.

Electric lighting is progressing without great speed. This is largely on account of the fact that in many of the towns the municipalities are under contract with the gas companies to preserve their monopoly in lighting. This has resulted also in the selling price of electrical energy being much too high. Meanwhile in some places the gas companies appear to have decided to install for themselves electric stations, where, on account of other concessions, they are in competition with the gas installation belonging to another company. This new attitude of the gas companies allows the hope that electric lighting will soon meet with a considerable extension.

The extension of the application of electricity has necessarily had for its consequence the growth of the manufacture of apparatus for its generation and utilization. The construction of the direct-current dynamo has been the opportunity for much labor for the perfection of detail, and, above all, for the reduction of dimensions for a given power. The construction of alternators permits to inventors the realization of the most marked perfection. During the year the Farcot concern delivered to the central station at the Champs Elysées some alternators built on the Leblanc and Hutin systems, which have shown considerable economy. The transformation of direct current into alternating and the inverse transformation have been the object of much study. Several Alioth rotaries are now in operation in generating stations, and the fears which were expressed at the beginning of their employment do not appear to be justified, those who are using them having spoken with satisfaction of their operation. Meanwhile M. Leblanc is making practicable his system of transformation by means of rectifiers, and trials recently made on those installed on the electric system of the Compagnie des Chemins de Fer du Nord have left no doubt about the practical value of this system. The accumulators which are becoming more and more generally used in generating stations and for traction, and which seem to continue to be employed, at least in Paris, for accumulator traction, have naturally been the object of many detailed studies, but there is no extraordinary progress to recount. The announcement has just been made of the appearance of a new accumulator made of zinc, and having, over the present types, the advantage of relatively small weight for given capacity, and consequently great convenience for accumulator traction.

If we look upon the progress accomplished this year in France in electrical industries, we should feel satisfied with the results accomplished in the diverse branches of its application, and particularly with those achieved in traction and electro-chemistry. So, looking at the future, I can predict that a rapid extension of these two applications will take place, and at no far future time there will be considerable development in the utilization of waterfalls. The electric industries in France, without being in as satisfactory a condition as one could wish, are yet at this time unquestionably on the road to marked progress.

An Electric Mail Wagon.

The British Post Office has had on trial in London an electrically driven van for the carrying of mail matter between the main office and the sub-stations. The experiment at the start seems to be highly successful.

Some Laws of Rotary Transformers—I.

BY J. E. WOODBRIDGE AND CHARLES T. CHILD.

THIS brief analytical discussion of certain proprerties of rotary converters proposes to deal with the questions presenting themselves in the practical design of such machines. The rating of rotaries with regard to their capacity and a comparison of the various types of single and multiphase machines will be considered, as well as some considerations of proportion hitherto, so far as the writers know, not published.

It is unnecessary to discuss here at great length the obvious and manifold advantages of the single winding rotary, in which the transformation from alternating to direct current, or vice versa, is effected in one set of coils, over the more elementary type of motor generator, in which two distinct machines are coupled together for the same purpose. The far greater capacity of the single-winding type over two separate machines aggregating the same weight, the absence of armature reaction, field distortion and mechanical torque, and the better regulation secured by the use of the former are well known. The rotary, furthermore, so far as the alternating side is concerned, being a synchronous motor with an excited field, allows of the maintenance of the power factor at or near unity by adjustment of its field strength, thus eliminating wattless currents from the system. In cases where other loads are causing lagging currents upon the system the rotary, by over-excitation of its fields, can be made to serve the purposes of a condenser and by taking leading currents balance out the lagging currents and bring up the power factor of the system of supply to unity. The rotary does not in itself, however, allow a wide variation of the ratio of the voltages between the two currents as does the motor dynamo, since the ratio of voltage transformation between the two varieties of current is a fixed quantity and cannot be changed by any manipulation of the field excitation. This is strictly true only if the voltages at the terminals of the machine on its two sides are considered. The reactive effect of the rotary upon the line and generator to which it is connected may be made to give a voltage variation, within limits, if the effect upon the rest of the system is not objectionable.

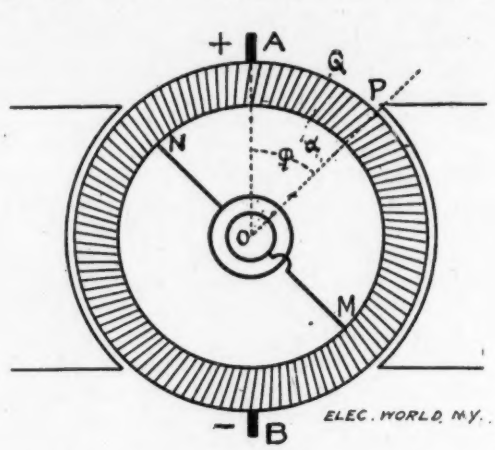


FIG. 1.—DIAGRAM OF SINGLE-PHASE ROTARY.

The difference of cost and maintenance between the rotary and the equivalent motor-generator combination is considerable and all to the advantage of the former.

The carrying capacity of any generator is limited either by the maximum permissible field distortion or the amount of heat which its parts will dissipate at the highest allowable temperature. In a rotary there is no field distortion whatever, as is evident from the fact that field distortion can only be caused by a mechanical torque or twisting effect on the armature. In a rotary the driving effect of the one kind of current just balances the dragging effect of the other, thus balancing out any field distorting effects. Hence, the transforming capacity of a rotary is, as a rule, limited by the maximum permissible generation of heat in its armature windings.

the $C^2 R$ losses in transforming a given amount of energy being very different from those evolved in generating the same amount of energy in the same armature used for direct or alternating current production. The effect differs widely between single-phase and polyphase machines, and the intention of the following discussion is to show the relative capacity of a given armature when used in a generator or a rotary transformer.

I.—THE SINGLE-PHASE ROTARY.

Proceeding first with the case of the single-phase rotary, and referring to Fig. 1, let us make the following assumptions:

We will take the field excitation to be such that the alternating currents are in phase with the back E. M. F., or in other words, assume the ideal case when the power factor is unity. We will neglect the internal losses of the machine, hysteresis, Foucault currents and mechanical friction, and assume that all the energy received through the alternating collector rings passes out through the commutator brushes, or vice versa. Fig. 1 is a conventional diagram of a two-pole two-path single-phase rotary, the direct-current brushes being shown at A and B, and the revolving connections to the alternating current collector rings being shown at M and N. It is, of course, only necessary to consider the currents in one side of the armature, as $A\ P\ M\ B$, the action being perfectly symmetrical about the line $A\ B$.

It is evident that the alternating and direct currents cannot simply be added together for the estimation of their joint effect, one of them being constant and the other variable, while their relative points of introduction are constantly changing.

Referring to Fig 1, we will assume that the armature is turning at synchronous speed and that the direct current is flowing in at brush B and out at A, or upward through the diagram. Then if P is the middle point of the section of the armature $N\ A\ P\ M$, we may take φ to be the angle $A\ O\ P$ between the line of commutation $B\ O\ A$ and the line $O\ P$.

Then let V represent the direct-current voltage and C the direct current in one path through the armature winding, as $B\ M\ P\ A$, $2\ C$ being the total direct current flowing between the brushes A and B.

We then have V = maximum instantaneous alternating voltage.

$\frac{V}{\sqrt{2}}$ = virtual alternating voltage across the collector rings.

Then $C\sqrt{2}$ = virtual alternating current in one-half of the armature, since the total energy of the alternating side is equal to that of the direct-current side, consequently the product of the virtual alternating current and voltage must equal $C\ V$, the product of the direct current and voltage,

and $2\ C$ = maximum instantaneous alternating current in one side of the armature.

Let α be the angular distance between any conductor on the active surface of the armature, such as Q, and the point P, and let r be its resistance. The direct current in it will be C; the alternating current at the instant represented will be $2\ C \sin \varphi$. The resultant of these two currents will be

$$C - 2\ C \sin \varphi \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The rate of heating at the instant represented will be

$$\{C - 2\ C \sin \varphi\}^2 r = C^2 r \{1 - 4 \sin \varphi + 4 \sin^2 \varphi\}$$

To find the total heating effect during one-half a rotation (the effect obviously being symmetrically and exactly repeated at every such period), this expression must be integrated:

$$C^2 r \int \{1 - 4 \sin \varphi + 4 \sin^2 \varphi\} d\varphi = C^2 r \{3\ \varphi + 4 \cos \varphi + \sin 2\ \varphi\}$$

This only holds good while the point Q is moving from one brush to the other. We may, therefore, apply the limits $\varphi = \alpha$ and $\varphi = \pi + \alpha$. When $\varphi = \pi + \alpha$ the expression becomes:

$C^2 r\ (3\ \pi + 3\ \alpha - 4 \cos \alpha + \sin 2\ \alpha)$, and when $\varphi = \alpha$
$C^2 r\ (3\ \alpha + 4 \cos \alpha + \sin 2\ \alpha$.

Subtracting the second expression from the first gives the value of the total heating effect in the conductor while it is traversing an arc equal to the difference between the two limits. Hence, to find the rate of heating this difference may be divided by π which gives

$$3 - \frac{8}{\pi} \cos \alpha \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

as the ratio of the heating effect in the section under consideration to the heating if the machine was generating the same load as a direct-current dynamo.

Evidently the distribution of heat is not uniform in the different coils of the armature, as is the case when generating either direct or alternating current, but depends upon the position of the coil relatively to the points at which the collector rings are connected with the windings. This variation is shown in the accompanying curve, Fig. 2, in which the angular distance of a coil from one collector ring lead is plotted horizontally and the heat generated in it is plotted vertically. It may be seen from this that the windings immediately adjacent to the collector ring connections in the case under consideration, with the power-factor unity, suffer a heating effect over six times as great as those midway between the points of introduction of the alternating current. This, of course, assumes that all the parts of the winding are of the same gauge.

Since the expression (2) gives the value of the heating effect in the rotary coils in terms of that produced in the same coils when the machine is driven by mechanical means as a direct-current generator with the same output, the heavy horizontal line, with an ordinate unity, in Fig. 2, shows the heating effect on the coils under the latter consideration. It may be seen that the coils midway between the leads suffer less than half the heating effect produced in them when the machine is working as a direct-current generator, while those immediately adjacent to the leads suffer three times as much. This

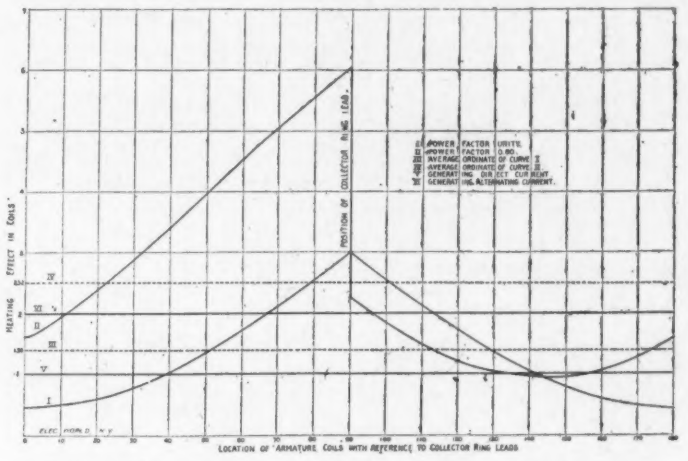

HEATING EFFECT IN COILS
POSITION OF COLLECTOR RING LEAD.
I POWER FACTOR UNITY.
II POWER FACTOR 0.80.
III AVERAGE ORDINATE OF CURVE II.
IV AVERAGE ORDINATE OF CURVE I.
V GENERATING DIRECT CURRENT.
VI GENERATING ALTERNATING CURRENT.
LOCATION OF ARMATURE COILS WITH REFERENCE TO COLLECTOR RING LEADS

FIG. 2.—DISTRIBUTION OF HEATING EFFECT AROUND THE ARMATURE.

value of the heating effect was based upon the assumption of unity power factor. If, however, the field excitation is such that the back E. M. F. does not bear a suitable ratio to the impressed E. M. F. the effect will be quite different, as wattless currents will flow in the armature and increase the heating effect. By introducing in the expression (1) above, the proper changes for an angle of lag or lead of the alternating current β the expression (2) becomes

$$3 - \frac{8}{\pi} \cos \alpha + 2 \tan^2 \beta + \frac{8}{\pi} \tan \beta \sin \alpha \ldots\ldots (3)^*$$

The representation of this expression for a typical value of β is interesting and is shown as curve II. of Fig. 2, the angle of displacement being 37°, corresponding to a power factor of 80 per cent. Here the symmetry of the heat distribution about the line of collector ring connections is lost, owing to the fact that the coils immediately following these connections, as the armature rotates, have the maximum alternating current piled up cumulatively on the direct current in the case of lagging loads, while those immediately preceding the collector ring leads suffer the same effect in the case of leading currents. The maximum heating is now six times that of the same coils generating direct current, and the minimum (no longer at the middle of the section) is about equal to the direct-current effect.

The most important consideration in the rating of these machines is the average heating loss in their armatures, which, for equally cool running, must be limited to that of the maximum current of the same machine used as a dynamo. The average heating effect may be

* Expression (1), with currents out of phase with the back E. M. F, by an angle β, becomes $\left\{ C - \frac{2C}{\cos \beta} \sin (\varphi + \beta) \right\}^2 r$.

Expanding and integrating this with regard to φ, applying the limits α and $\pi + \alpha$, and dividing by π gives the expression (3)

best obtained by integrating (2), considering α, the angle between the element under consideration and the middle of the coil, to vary through the half armature between the two leads.

$$C^2r\int\left(3-\frac{8}{\pi}\cos\alpha\right)d\alpha=\left(3\alpha-\frac{8}{\pi^2}\sin\alpha\right)C^2r.$$

Applying the limits $\alpha=\frac{\pi}{2}$ and $\alpha=-\frac{\pi}{2}$ the expression evaluates as $\left(3\pi-\frac{16}{\pi^2}\right)C^2r$ which, divided by the difference π between the limits, gives

$$C^2r\left(3-\frac{16}{\pi^2}\right)=1.38\,C^2r.....(4)$$

Thus, it may be seen that, under the conditions assumed, any direct-current machine used as a single-phase rotary will dissipate as C^2 R armature loss at least 38 per cent. more energy when working

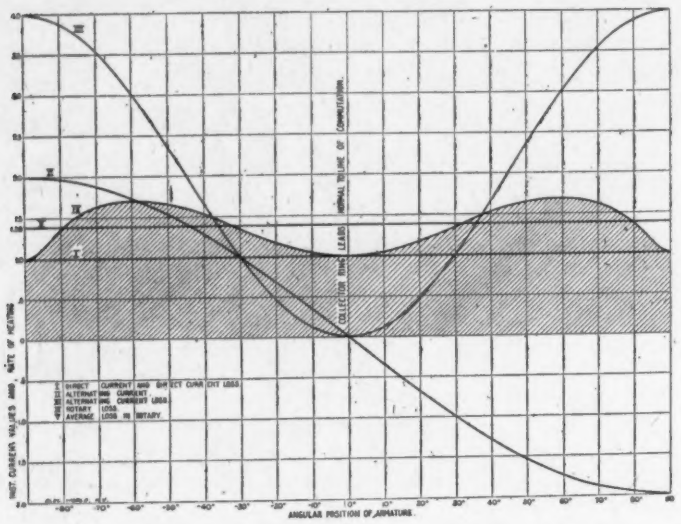


Fig. 3.—Time Variation of Currents and Heating.

at the same output. To determine, therefore, the safe load of a machine with a known generating capacity when worked as a single-phase rotary, let K be this safe transforming current capacity; then

$$1.38\,K^2r=C^2r$$

from which $K=0.85\,C$.

Hence, with unity power factor, the rating of a single-phase rotary transformer should be 85 per cent. of that of a direct-current generator or motor of the same dimensions. This, however, assumes that the current and E. M. F. on the alternating side are in phase with each other, and that both are sinusoidal. By integrating** the expression (3) it may be shown that with an angle of displacement β the value of the total losses becomes

$$C^2r\left(3-\frac{16}{\pi^2}+2\tan^2\beta\right).....(5)$$

Assuming, as before, a power factor of 80 per cent., corresponding to an angle of displacement, either leading or lagging, of about 37°, this value becomes 2.5. In other words, the transforming capacity is reduced to about $\frac{1}{\sqrt{2.5}}$ or 63 per cent. of the generating capacity.

This figure, however, makes no allowance for the unequal distribution of the heat generation, the effect of which depends, of course, on the thermal conducting qualities of the armature. In view of this fact the transforming capacity of a single-phase rotary can hardly be safely estimated at much over one-half its generating capacity, unless its power-factor is closely maintained near unity.

** $\int\left(3-\frac{8}{\pi}\cos\alpha+2\tan^2\beta+\frac{8}{\pi}\tan\beta\sin\alpha\right)d\alpha=$

$$3\alpha+2\alpha\tan^2\beta-\frac{8}{\pi}\sin\alpha-\frac{8}{\pi}\tan\beta\cos\alpha$$

When $\alpha=\frac{\pi}{2}$ this becomes $\frac{3\pi}{2}+\pi\tan^2\beta-\frac{8}{\pi}$.

When $\alpha=-\frac{\pi}{2}$ it becomes $-\frac{3\pi}{2}-\pi\tan^2\beta+\frac{8}{\pi}$.

Subtracting and dividing by π gives $3-\frac{16}{\pi^2}+2\tan^2\beta$

A highly interesting corollary of this discussion is the fact that the same machine wastes twice as much energy when used as an alternating-current generator or motor as when working as a direct-current machine. This is due to the fact that the virtual alternating current corresponding to a direct current C is equal to $C\sqrt{2}$, the square of this being obviously $2C^2$. The generation of this heat is, of course, uniformly distributed throughout the armature, but in case of the alternating current it varies with the time. Fig. 3 shows these variations. Another interesting point is the variation of the heat waste with the angular position of the armature of the machine as a rotary. This is also shown in Fig. 3. The equation of this curve is easily shown to be

$$\text{Loss}=C^2r\left\{1+4\sin^2\varphi-\frac{8\varphi\sin\varphi}{\pi}\right\}.....(6)$$

A consideration of the physical actions in the rotary armature shows that when the collector ring attachments are midway between the points of commutation the alternating E. M. F. and current are zero, the C^2R loss being solely that due to the direct current. This is shown by the flat middle part of the curve of rotary loss in Fig. 3, the sudden dip to the same value at the instant when the collector ring leads are immediately under the brushes being due to the fact that, at that instant, the alternating current reaches its maximum flow of $2C$. The alternating current input then supplies the direct current output and exactly as much more which flows down against the E. M. F., bringing the instantaneous loss to unity.

Obviously, at this instant, the machine is working as a motor, as the power given to it by the alternating current is twice as great as that given out. One-quarter period later the machine acts purely as a generator, there being no input whatever and the output, of course, being of uniform value. The rotor, therefore, has to act as a fly-wheel, being accelerated during one-quarter period and retarded during the next, there being thus a sort of double electrical mechanical transformation involved. What this acceleration and retardation amounts to in machines of standard type is beyond the province of this paper to determine, but it is obvious that it involves an alternating armature reaction with a frequency twice that of the alternating current, tending to distort the field magnetization alternately into the leading and following horns of the pole pieces, and with a maximum instantaneous value equal to the reaction of the same machine generating the same output of direct current. In solid poles this will naturally cause serious eddy current losses, while with laminated poles the alternating distortion will obviously so oscillate the plane of commutation that no position can be found for sparkless running unless the induction across the air-gap is carried so high that the reactive crowding is rendered negligible.

Automatic Window Blinds.

What we believe to be the latest development in automatics, says the London *Electrician*, is a window shade recently introduced by a Berlin firm. As soon as the sun shines on the room or window to be protected the blind lets itself down, and when the sun "goes in" the blind draws itself up again. Two glass bulbs are connected by a *U*-tube partially filled with mercury. A platinum wire melted into the glass makes contact with the mercury at the bend of the tube, and there are also platinum contact-wires brought into the sides of the tube, one of which is in contact with the mercury only when it stands level on the two sides, and the other only when the mercury in one side of the tube rises. One of the bulbs contains only air, the other is filled with black wool. When no sun is out the air in the two bulbs occupies the same volume, and the mercury stands at equal heights in both legs of the tube; but when the sun is shining, the bulb with the black wool absorbs the sun's rays, and causes the mercury to rise in the opposite side of the tube. This closes the circuit of a motor which lets down the blind, an automatic switch switching off the current as soon as the blind gets to the end of its range, and reversing the connections of the motor so that it is ready to wind up the blind as soon as the other contact in the tube is made. When the blind reaches the top the current is again switched off, and the connections are reversed at the switch.

Church Services by Telephone.

On Christmas Day the patients of All Souls Hospital, at Morristown, N. J., were all provided with telephone receivers connected to a transmitter in the Church of the Assumption, a mile away, and enjoyed the music and sermon of a special Christmas service.

The Past Year's Advance In the Art of Telephony.

BY KEMPSTER B. MILLER.

IN these days the practical development of any art may be most easily studied and best understood by a careful consideration of the patents in that art granted during a certain time. Indeed, several years' experience in the United States Patent Office has led me to the conclusion that, except in rare cases, any contribution to the knowledge of the practical arts will be found described, if anywhere, in the patent specifications of this or some foreign country.

In the year just ended nearly 250 patents for alleged improvements in the art of telephony were granted in the United States. Of these the greater number relate to systems for facilitating the rapid interconnection of stations. Comparatively few attempts have been made toward the improvement of telephone instruments proper, and these are for the most part uninteresting and unimportant. From a theoretical point of view several radically new

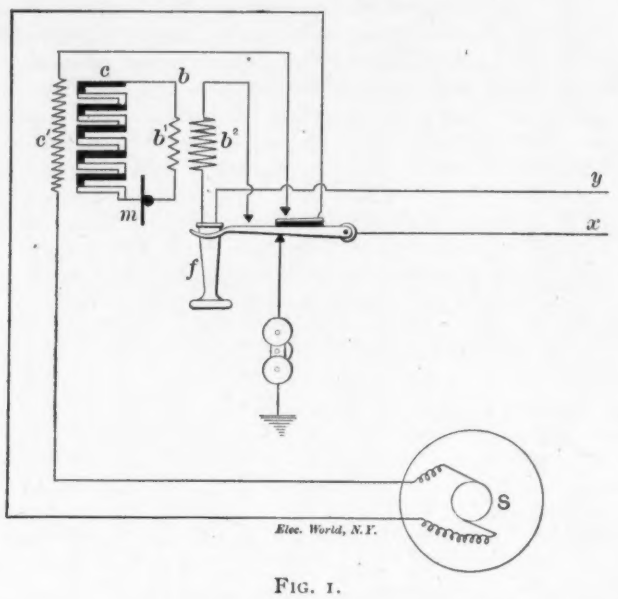


FIG. 1.

contributions have been added, some of which will undoubtedly prove of great value when further and more perfectly developed.

The problem of supplying the subscriber's transmitter with current from a central source, which, since 1894, has been receiving more and more attention, has been attacked in a radically novel way by Mr. W. W. Dean, who has already done much in this line of work. He proposes to replace the ordinary chemical generator or battery at each subscriber's station by a thermal generator or thermopile, heated when in use by some external source of current. The arrangement of apparatus is shown in Fig. 1, in which *x* and *y* are line wires leading to the central office of the telephone exchange. The telephone receiver *f* and secondary *b2* of the induction coil are placed in the line circuit, as in ordinary practice. This circuit is normally open, but is closed by the hook switch *e*, when released from the weight of the receiver. The transmitter, *m*, the thermal generator, *c*, and the primary coil, *b'*, are placed in series in the local circuit, which is permanently closed. The resistance coil, *c'*, is in a circuit in which is included a generator, *S*, which may be either a dynamo or battery. The circuit through the coil, *c'*, and the generator is normally broken at the hook switch by additional contacts carried thereon. When, however, the receiver is lifted, this circuit is completed, and the coil *c'* becomes heated, since it is the point of highest resistance in its circuit, and thus puts the thermopile into action. The action of the apparatus in talking is precisely the same as if a chemical battery were used.

If the house in which the telephone is used is provided with an electric light circuit constantly charged, very little extra wiring will be required to run a circuit to the telephone instrument, to be used for supplying heating current to the thermopile. The current which it in turn generates will be practically constant. In order to render it unnecessary to run separate wires from the source of current into each house, Mr. Dean has worked out a system by which current is applied to the thermopile over the two

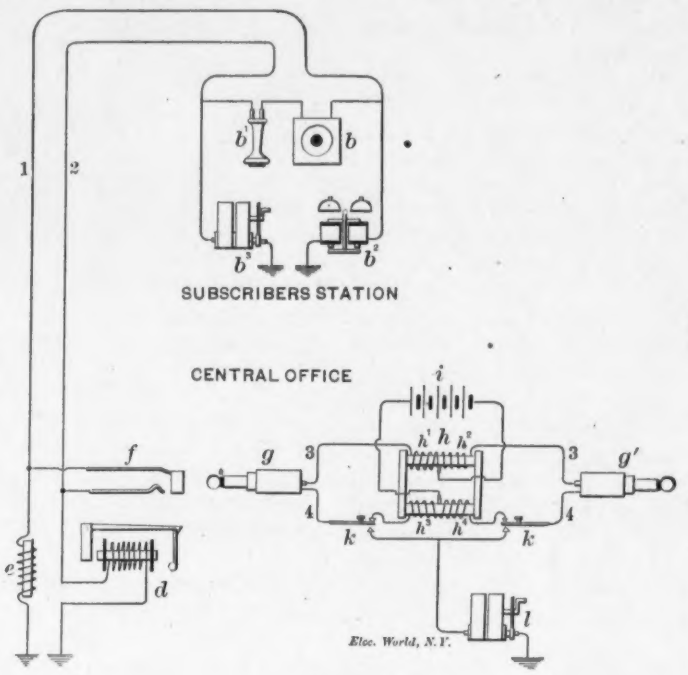


FIG. 2.

wires of the telephone circuit in multiple, the return being made through the ground. Properly arranged retardation coils prevent the short circuiting of the voice currents, while they allow the passage of the comparatively steady battery or dynamo currents from the generator *S*.

Another centralized battery system due to Mr. C. E. Scribner, of the Western Electric Company, is shown in Fig. 2, and is interesting principally because it is designed to dispense entirely with all switches, either automatic or manual, in connection with the telephone and signalling appliances at the subscriber's station. The transmitter *b* and receiver *b'*, at the subscriber's station, are in series in a wire bridged between the two line wires. One side of the line is grounded at the sub-station through a high-wound bell, *b2*, and the other side is similarly grounded through a high-wound generator, *b3*. At the central office, that side of the line containing the subscriber's generator is grounded through a high-wound annunciator, *d*, while the other side of the line may be left open, but is preferably grounded through an impedance coil, *e*, in order to preserve the balance of the circuit. The two contacts of the line jack *f* are connected respectively with the sides 1 and 2 of the line between the annunciator and the subscriber's station.

A common battery, *i*, is bridged through proper impedance coils across the cord circuit of each pair of plugs and supplies current for the transmitter of each of the lines to which the plugs *g* and *g'* may be connected. The generator *l* may be connected by either of the keys *k k* to the sleeve side of the cord circuit, which connects with that side of the line containing the subscriber's bell.

Several years ago when agitation was rife concerning the use of the automatic hook switch, the patent covering this system would have been extremely valuable in the hands of one of the opposition companies. This is typical of one type of common battery system, which has met with considerable success in practice within the past few years, in that no induction coil is used at the subscriber's station, the transmitters being connected serially in the line circuit with the receiver. This seems like returning to first principles, but the very satisfactory results obtained in practice warrant its adoption in many cases. In systems of this kind the receivers are made of low resistance, from 10 to 25 ohms, while the transmitters are of high resistance, from 100 to 150 ohms. These resistances are taken in order that the changes in resistance pro-

duced by the transmitter shall bear as great a ratio to the total resistance of the circuit as possible. An instructive feature in this system is that it shows with what freedom coils of high resistance and impedance may be bridged between the sides of a metallic circuit and ground without materially affecting the talking efficiency.

The use of storage batteries at the subscribers' stations charged by current constantly flowing in the lines from a central source while the telephones are not in use has in the past year been meeting with more and more favor in practice. Storage batteries are in many respects peculiarly fitted for telephone work. Their extremely low internal resistance and their ability to maintain a constant E. M. F. for a considerable period are obviously advantages over the primary battery.

In Fig. 3 is shown a system of this kind, due also to Scribner, and designed to permit an alternative mode of operating the telephone in the event of a complete discharge of the local storage battery. Advantage is taken of the fact that if, when a storage cell is entirely discharged, a charging current is sent through it, a considerable counter E. M. F. is set up, which may be nearly

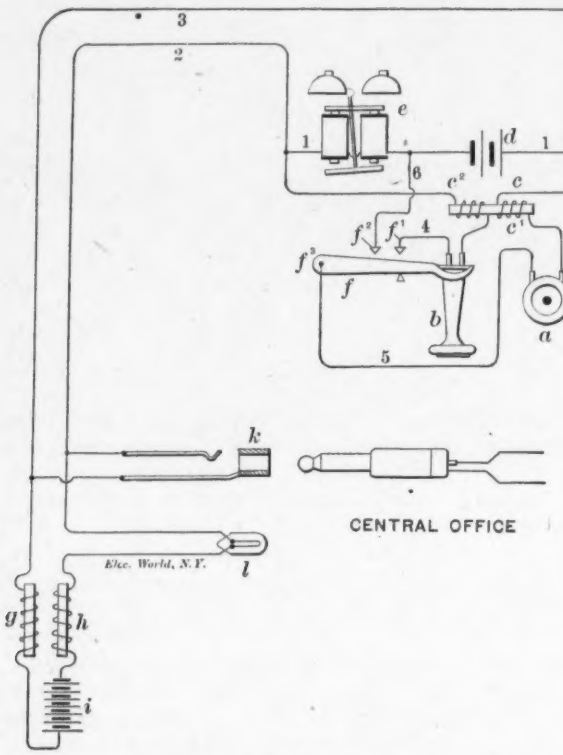


Fig. 3.

equal to that of a charged cell. The storage battery *d* and the signal bell *e* of high resistance are in series in a wire permanently bridged across the two sides of the line wire at the subscriber's station. When the hook switch is raised, a circuit containing the primary *c'* of the induction coil and the transmitter *a* is bridged around the storage battery *d*, while another circuit containing the secondary *c2* of the induction coil, and the receiver *b* is bridged around the call bell *e*. On entering the exchange the line conductors are led through the impedance coils *g* and *h* to the terminals of the central charging battery *i*. An ordinary branch terminal, spring jack *k*, is used for making connection with the line, and between this and the battery *i* is a lamp, *l*, used as a signal for that line. The battery *i* creates in the line a current, which circulates while the line is not in use through the local storage battery *d* and the bell *e* at the sub-station.

The local battery is thus continuously receiving a charging current. When the receiver *b* is brought into use, a low resistance path is formed around the bell *e*, and sufficient current is permitted to flow in the line to illuminate the lamp *e*, and signal to the operator that her attention is desired upon that circuit. The local circuit of the battery *d* is also closed through the transmitter, which acts in conjunction with the other parts of the apparatus, as in the ordinary telephone. If from some cause battery *d* becomes nearly or quite discharged, the current which tends to flow from the central charging battery *i*, through the line circuit, battery *d*, receiver *b* and the secondary coil *c2* will cause a considerable counter E.M.F. to be set up in the battery, which will divert a large portion of the current through the primary circuit around the battery, and this current will in this case serve to actuate the transmitter. This contrivance diminishes the danger of interruption to the service due to the failure of exciting current, for the transmitter *a* at the sub-station will always be supplied with current, whether or not the battery *d* is charged. The chief beauty of this system, however, lies in its extreme simplicity.

A growing tendency is shown toward the use of incandescent lamps both for line and clearing-out signals in the central office. When used as line signals, they are some times included directly in the line circuit, as in the preceding patent, but are more often placed in separate local circuits, each controlled by a relay in its own line wire. There is little doubt that magneto generators at sub-stations will soon be a thing of the past, and that signaling from subscriber to central will be accomplished, as in the two preceding patents, by some centrally located source of current allowed to operate by the removal of the subscriber's receiver from its hook. Many multiple switchboard exchanges are now being equipped with a common battery and common calling generator system; moreover the past year has, to a great extent, demonstrated the entire feasibility of this mode of operation.

Several systems of selective signalling on party lines have been devised during the past year, but the only one of them which, so far as the writer is aware, has gone into actual operation is that designed by Messrs. Barrett, Whittemore and Craft. This is designed to be used on metallic circuits only, and depends for its operation on sending currents of either polarity or different combinations of currents over the two-line wires and ground as is required. For an understanding of this system reference is made to Fig. 4, which shows the arrangements of circuits for the signaling apparatus of eight stations and of the central office equipment. *A* and *B* represent two line wires extending from central station *C* to eight stations, *S1*, *S2*, *S3*, etc. The principles upon which this system is based are briefly as follows: Without using the wire *B* at

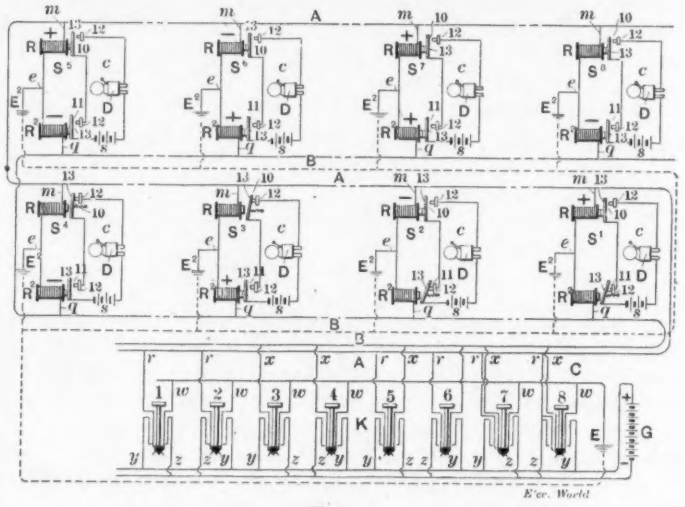


Fig. 4.

all, a current in either direction could be sent over the wire *A*, using ground as return, thus giving means for two selective signals. Similarly, leaving *A* out of the question, a current in either direction could be sent over the wire *B*, using ground as return, thus giving means for two more selective signals. Two more can be obtained by using wires *A* and *B* in series and disregarding the ground, and still two more by sending currents in either direction over the two wires in multiple using the ground return. Certain other combinations of current may be obtained, but owing to practical considerations are deemed unavailable for use.

At each of the eight sub-stations are two relays, *R* and *R2*, placed in derived currents or earth branches, *m* and *q*, of the two main conductors respectively. These branches are united at *e*, and have a common earth connection *E2*. There is at each station a signal receiving bell *D*, placed with a battery in a local circuit, capable of being opened and closed at two points, 10 and 11. and which stands normally open at either end or both of such points. The relays *R* and *R2* control this local circuit at each sta-

tion, and when the armature levers 13 of both rest on the contact stops 12 the said circuit is closed and the bell will ring. It will be observed that the relays of each station differ in some way either in construction or arrangement from those at all other stations. Thus at station *S'* the main conductor *A* is branched through a polar relay made responsive to a plus or positive current and main conductor *B* through a neutral relay adapted to respond to currents of either direction passing through *B*. Station *S2* also has a neutral relay on line *B*, but has a polar relay responsive to a *minus* current on line *A*. The differences of arrangements at all the stations are easily seen by reference to the diagram. The polar relays hold their local circuit contacts open at all times, except when the coils are traversed by current of the proper polarity actuate their armatures. Upon cessation of such current the armature resumes its normal position, thus opening the local circuit.

At the central station *G* is a generator of calling current, and *E* an earth connection complimentary to the earth connections at the sub-stations.

K is a group of singnaling keys, each corresponding with one substation appliance; and when any particular key is pressed the relays at the particular sub-station represented by it will co-operate to close the local circuit and give the signal there; but at the other stations no such effect will take place. Hence to give a signal at any desired sub-station, it is only necessary to operate the particular key representing such station.

For instance, in key No. 1 the contacts are so disposed that its operation will connect conductor *A* with the plus generator pole at contacts *v* and *y*, the minus pole of the generator with the earth-terminal contacts *z* and *w*, and will leave conductor *B* disconnected. By this means a plus current is sent over line *A*, and is distributed over all the *A* relays at all the sub-stations in parallel, finding return through the earth branches at the said stations, but as no current is transmitted over line conductor *B* all of the eight *B* relays will remain unaffected. Under these conditions relay *R* at station *S* will close the open point 10 of its local circuit, and the point 11 being already closed by the normal position of the armature of relay *R2*, which has not been changed, the local circuit *c* of station *S* will be closed, and the bell at this station will be rung; but station *S2* will not be signaled, because, the plus currents having no effect on the polar relay *R* of minus sign there, its local circuit remains open. A little consideration will show why the bells at the remaining stations will not respond. It will be found that any one of the keys will send to line a current combination that will cause the relays of its corresponding station to close their local circuits, while the local circuits at all other stations will remain open.

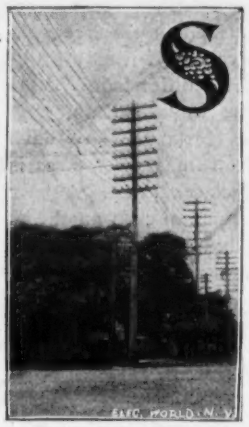
In applying the foregoing principles to a practical multiple station circuit system, it is found desirable to reserve two of the current combinations for the operation of locking devices, common to all the stations. Consequently a plus current is used over both conductors *A* and *B* in multiple for locking telephone apparatus at stations other than that where the circuit is in use, and a minus current over both lines for unlocking. Six combinations are thus left for selective signaling, which generally is a sufficient number of stations to be served by a single circuit. The telephone locking device and the visual busy signal mechanism have been carefully worked out in connection with this system, but space will not permit their description here.

Journalism in the Klondike.

The "Midnight Sun" is the name of an enterprising newspaper printed in Dawson City. The editor thereof is looking forward, with much anticipation, to the time when wireless telegraphy will be an accomplished fact, and he is already making preparations to avail of its advantages in behalf of his publication. He is according to an editorial in our sprightly contemporary, "fixing up" a receiving station on his roof garden to catch all the late news that may float in the upper air currents. These waves of intelligence he says will probably have to be thawed out before they can be deciphered, but he has provided for such an emergency, by connecting a hot-air cylinder with his receiving apparatus. "No expense will be spared," he remarks with enthusiasm, "to make the 'Midnight Sun' the finest example of advanced journalism north of Galveston."

Wireless Telegraphy.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.



STRICTLY speaking, the term wireless telegraphy includes all methods of transmitting signals between distant points, not embraced in ordinary electric telegraphy. Thus, the early well-known forms of semaphoric signaling, heliographic signaling, flag, or lantern signaling, and acoustic signaling, were all types of wireless telegraphy. Of recent years, however, the term wireless telegraphy has become associated with means for electric signaling in which the usual wire connecting the transmitting and receiving instrument has been dispensed with, and the intervening air, water or earth has been compelled to serve in its place.

It is now generally admitted that the ordinary method of wire telegraphy consists in directing the flow of electromagnetic waves through the ether between the transmitting and receiving station, by guiding these waves in their passage along the conductor connecting the two stations. On the other hand, wireless telegraphy consists in directing these waves from the transmitting to the receiving station without the use of the guiding conductor. Both wireless telegraphy and wire telegraphy, therefore, agree in the fact that electromagnetic waves carry the signals from the transmitting to the receiving apparatus; they differ, however, in that in wire telegraphy they are guided along a conductor; whereas in wireless telegraphy they are not so guided, but are directed by other means.

Clerk Maxwell in 1864-1865 announced the hypothesis that electromagnetic waves are of the same nature as light, but are unable to excite the sensation of light, owing to their low frequency. He was led to form this hypothesis from an analysis of the behavior of electric and magnetic disturbances, as developed in material media under experimental conditions. According, therefore, to the theory which Maxwell was the first to suggest, all systems of electric telegraphy consist essentially in producing and transmitting invisible light waves, either with or without a guiding conductor, and of causing these waves to affect a suitable receiving instrument.

From an experimental point of view, evidence had been obtained at a comparative early date of the possibility of transmitting electric disturbances to a distance by inductive action, as distinguished from conductive action. Thus, the return stroke of lightning has long been known to be an inductive effect transmitted by the method of wireless telegraphy, from the immediate neighborhood of a lightning discharge to distant points covering a wide area. On a smaller scale, Professor Henry observed in 1842 that the discharge of a condenser in the upper room of his house was capable of magnetizing stel nedles in his cellar. In this case the eectro-magnetic waves, generated by the disruptive discharge of the condenser, were enabled to pass through the intervening floors and air spaces, and produce in the needles permanent magnetic effects.

As soon as the conductors of the ordinary electric wire telegraphy began to spread and extend themselves between cities, it was found that electric signals transmitted on one wire produced electric disturbances in neighboring wires. Some of these disturbances were traced to conduction or to leakage of the current between wire and wire, but in other cases the disturbance was found to be of an inductive nature. In other words, the electro-magnetic waves, guided along the working conductor, impinged also upon the surface of the neighboring conductor, and set up in its circuit the electric disturbances observed.

The advent of the telephone and the telephonic system brought this inductive influence between neighboring conductors into prominent notice, and attention had to be given, by those designing telephone circuits, to avoid the inductive "cross-talk," which at first gave so much trouble. The sensitiveness of the telephone, when employed as a receiver, showed, moreover, that inductive disturbance, due to lightning, could be detected in telegraph or telephone circuits at points many miles from the lightning discharge, while telegraphic signals transmitted on one circuit were found to be audible in a parallel circuit, when separated by a distance of several miles.

At the Chicago Electrical Congress of 1893, Mr. W. H. Preece read

a paper on the subject, in which he described experiments made on the Bristol Channel, between the mainland and a neighboring island, the signals being transmitted inductively, and received by means of a telephone. The maximum distance at which signals were successfully received was a little more than three miles.

The experimental researches of Hertz, published in 1888, corroborated the theory of Maxwell, and appear to render it highly probable that the succession of electromagnetic waves differ from visible light only in the frequencies or lengths of the waves. Employing the principles of resonance, the methods of Hertz seem to have shown that the velocity of transmission of electromagnetic waves is the same as the observed velocity of light (300,000 kilometres per second, approximately), within limits of experimental error, and that electromagnetic waves can be reflected, refracted and polarized like light waves. It would seem in fact that the only important experimental evidence lacking to establish the identity of the two sets of phenomena, is the production, by artificial means, of a luminous frequency of alternating electromagnetic waves; and actually observing whether they produce the sensation of light. The shortest waves that can yet be experimentally produced are a few inches long, whereas the lengths of the waves in ordinary light are but a few one hundred thousandths of an inch.

Hertz found that the electromagnetic waves produced by the disruptive discharge of a condenser were radiated from the spark gap into the surrounding space, and that within a range of a few yards they could be detected by a receiving instrument, consisting of a resonant electric circuit, interrupted by a very narrow spark gap, in which a tiny spark could be observed in a dark box. Such a receiving instrument is comparatively insensitive, since a very appreciable E. M. F. must be produced in the resonant circuit, in order to cause a spark to jump across the gap.

Other observers in repeating and extending the experiments of Hertz produced other forms of receiving instruments. Among these were impulsion cells, thermo-electric junctions, bolometer wires, vacuum tubes, and coherers. The last were so named by Dr. Oliver Lodge. It was found by Branly, in 1890, that a mass of metallic powder or filings had its electric resistance greatly lowered when subjected to low-frequency light; *i. e.*, to electro-magnetic waves produced by a Hertz radiator. The metallic powder was placed inside a glass tube furnished with electrodes inserted at opposite extremities. The resistance of the column of powder between the electrodes was often enormously great, due to the imperfect contact between adjacent particles. When an electro-magnetic wave strikes such a tube, the electromotive intensity present in the wave sends a momentary electric discharge or current through the metallic mass, which has a tendency to electrically weld together the successive particles, or to reduce their contact resistance, so that the particles cohere electrically after the passage of the electric wave. The original high-resistance condition of the apparatus can usually be restored by tapping or shaking; that is to say, the coherer may be made to decohere by mechanical disturbance. Such an instrument, when used in connection with a Wheatstone bridge, battery and galvonometer, shows, by its sudden diminution in resistance, the moment when an invisible ray of low-frequency light has impinged upon it.

Dr. Oliver Lodge described in his lectures before the Royal Institution, in 1894, a number of experiments made with coherers, and showed that it was possible to produce in this way an electric eye that could register the impact of invisible rays at a distance of more than forty yards, and he suggested that the limit might possibly be raised to half a mile. In the use of the coherer, or electromagnetic eye, it is inserted in the circuit of an electric resonator, which is tuned to respond to the frequency of invisible light emitted by the Hertz radiator employed. If the receiving instrument is placed anywhere within the range at which the invisible light is capable of affecting it, any excitation of the oscillator will cause a wave or succession of waves to radiate outwards in all directions from the oscillator, and which, arriving at the receiver, produce in the coherer an electric discharge, or series of discharges, that leave a permanent record in the reduced resistance of the instrument. In order to render the receiver capable of responding to a subsequent impulse, it is necessary to agitate the coherer, and cause it to decohere.

Quite recently the subject of wireless telegraphy has received a fresh impulse from the interest which has been manifested in the remarkable experiments of Marconi. The apparatus of Marconi, while not differing in type from that used by Lodge, yet has been found capable of transmitting signals successfully to a distance of about 9 miles across the Bristol Channel. The Marconi transmitter is essentially the Hertz oscillator. It consists of a pair of comparatively large metal spheres (about 10 cms. in diameter) mounted at a small distance apart in an insulating oil. A spark discharge from an induction coil is caused to pass through the oil at the gap between the spheres, the induction coil being excited by storage cells. The receiver is a particular form of coherer. It consists of a glass tube about 1½ inches long, and one-tenth or one-twelfth of an inch in internal diameter. The electrodes are inserted into this tube so as to almost touch, but to leave between them about one-thirtieth of an inch of space filled with the metallic powder. The artificial eye formed by this instrument is therefore about one-thirtieth inch long and one-twelfth inch in diameter, so that the volume of the active portion is only about the one-five-thousandth part of a cubic inch, or about one-two-thousandth of the size of the human eyeball. The powder is not compressed by the electrodes in this narrow space, but is left in a somewhat loose condition. The powder recommended by Marconi consists of 90 per cent. nickel filings and 10 per cent. hard silver filings, with a very small quantity of mercury. The coherer tube is partially exhausted to a vacuum of about 1mm. om mercury, and the tube is then sealed. The electrodes of the coherer are connected to "wings," or extension plates of metal, adjusted so as to make the radiator circuit resonant to the frequency emitted by the oscillator. The coherer, when in good adjustment, is sensitive to the electro-magnetic waves emitted by an ordinary vibrating electric bell, at a distance of one or two yards.

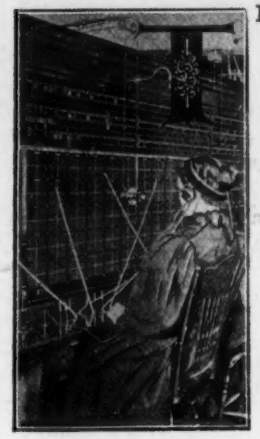
The coherer is connected in the circuit of a sensitive relay and a single voltaic cell. In the normal condition the coherer practically interposes an infinite resistance in the relay circuit. When a ray of invisible light falls upon the coherer, however, its resistance instantly falls, and the relay responds to the increased current strength. The local circuit of the relay causes a sounder to be energized, and at the same time a small electromagnetic trembler is operated, whose hammer strikes the back of the coherer, thus restoring its sensitiveness and normal resistance. By this means every ray of light which is emitted by the oscillator reduces the resistance of the coherer, or eye-relay, thus actuating the magnetic relay in its circuit, and this again actuating the sounder and trembler. It is necessary to short-circuit the break contact points of the relay and trembler with non-inductive resistances, in order to prevent the magnetic waves emitted at these points from directly influencing the coherer.

Substances which are nearly opaque to visible light rays are often transparent to light rays of low frequency. Thus, a thin barrier of wood is opaque to ordinary light, but wood offers apparently very little obstruction to the passage of Hertzian or Marconi rays. The waves employed by Marconi are about four feet long, or have a frequency of about 250 millions per second. Such rays are capable of passing through brick or stone walls, and nearly all ordinary building materials, so that it might be possible for an oscillator placed in one part of a city to influence a sympathetically tuned coherer, or artificial eye, placed in some other part of the city, even though houses and other barriers intervene.

The distance to which wireless telegraphy can be carried should depend upon the power of the oscillator, or the intensity of the rays it can emit, and the accuracy with which the rays can be brought into a parallel beam. It also depends upon the sensitiveness of the coherer or receiving instrument. The more powerful the transmitter, and the more sensitive the electric eye, the greater the effective range at which signals should be capable of being successfully transmitted. It may, perhaps, be found that, as greater range is secured a greater elevation becomes necessary, in order to avoid partial absorption of the rays by intervening hills or other obstacles. There can be little doubt that if the apparatus could be made practically reliable, it would at least prove of great use to vessels approaching a coast, if the neighboring lighthouses employed low-frequency rays. These rays could be detected by coherers on board a vessel, in spite of foggy weather. Heliographs also, which depend upon sunshine, might be supplanted at night, or in cloudy weather, by the artifically-produced light of the disruptive discharge. Since, only a few years ago, the working limit of wireless telegraphy by electro-magnetic waves was but a few yards, and now has reached nearly 10 moles, we may reasonably hope that the future will enable much greater distances to be successfully overcome, so that wireless telegraphy may take its place as a commercial application.

The Future of the Telephone.

BY LIEUT. F. JARVIS PATTEN.



THE perfection of the telephone, viewed as a practical working instrument for the commerce of the world, is now such that it is safe to assert that further extensibility along the lines of development heretofore followed is practically impossible, and in this particular it resembles closely the condition of the telegraph in the decade embracing the years 1840 to 1850.

At that time, it will be remembered, the longest line of practical service was from New York to Washington, a three circuit line with rather indifferent repeaters at Philadelphia and Baltimore. Even this distance, now comparatively small, was at best inadequately served, for the reason that the only repeater at that time known to the electricians of the day was crude and imperfect in design, and far from reliable in operation. It is true that there were minds who conceived theoretically the possibilities of further extension, but the monetary outlay required to put these theories into practice was then considered so great as to be absolutely prohibitive.

The first step in the further development of the telegraph coincides with the demonstration that a reliable automatic repeater was a solved problem by numerous devices, any one of which was comparatively cheap and sufficiently accurate for the most exacting service that it might be called upon to perform.

The indefinite extension of land telegraphy was assured by this fact, and the minds of inventors then naturally turned from this settled problem of land telegraphy to the far more difficult and more interesting one of establishing some form of telegraphic communication between the Old World and the New.

At first, the fundamental difficulties to be overcome appeared to be the material connection of the two continents and the enormous cost of this feature. But the critics and experts who knew all there was to know about electricity in those days added to the category of insuperable obstacles the utter impossibility of getting any such current over 3000 miles of straightaway line as could be required to work any known form of receiver. It would require, said these disheartening prophets, a battery house covering an entire block and three stories high, full of cups, to furnish the required electrical "intensity," as it was then expressed. The history of the cable is still so fresh in the minds of everyone that it is only necessary to rehearse in the briefest manner the facts connected with that great achievement. The cable was laid, and a battery of several thousand cups was connected up for "intensity," that is, in series for a voltage, but not a tick at the further shore recorded the fact that a key had been touched.

"Too little intensity," said the experimenters and would-be prophets, ignorant of the real conditions which acted as a bar to success, and ignorant even of the units and measures of the forces, the action of which they were endeavoring to direct and control. More and more cups were added to the battery, and the experiment tried again and again, with the same discouraging silence at the distant end of the cable.

"Why not try less battery?" was the rather discouraging suggestion of some genius whose name lies buried in obscurity, while his monument, the Atlantic cable, comes nearer to a realization of the poet's "federation of the world and parliament of man" than anyone would have dreamed possible at that time. Down came the battery to fifty cups, and then to five, when a signal at the distant end showed that these experiments were in the direction of success. With two cups a message was conveyed, and then the men of science realized that they were dealing with an entirely different kind of thing from the land telegraph line; that the problem here was not to convey current over the line to actuate a receiving instrument at the distant end, but that they must use the static charge of the line, charging and discharging it as a long drawn out Leyden jar, the release of the electric charge of which must be the operating force by which messages should be conveyed. In other words, a single cup the size of a thimble was sufficient battery power, under proper conditions, to operate a sensitive cable recorder. The Thomson recorder filled the necessary gap, and further perfection of the cable service was from that moment on a mere matter of attention to mechanical details. The rule seems without exception that in the experience of the past alone can we hope to discern the conditions of the future. Now, the analogy between the telephone and the telegraph is obvious, and we may reasonably look for a similar outcome of the former in the near future. The long distance line, from New York to Chicago, with the tremendous cost of its double copper wire and pole line of unusual height above the ground, necessary to overcome static disturbances, all combine to place a barrier dependent upon financial considerations to further extension of land telephony in this direction.

Theoretically, of course, it is entirely possible to talk from New York to San Francisco, the case of which would depend chiefly upon the height at which the wire was strung above the earth, and the amount of copper in the go and come conductors.

It must be remembered, however, that it is just such commercial propositions that have always been either the stimuli to or the deterrrents of electrical progress. In the throes of the commercial awakening which followed the stress of the war were born the perfected telegraph and the Atlantic cable. Commerce demanded them, and electrical science, which has always been the first to respond to any demands made upon it, said: "Lo! Here it is!" This much being premised, I think it is safe to assert that the next important step in the direction of the ultimate limits of telephonic connection will be a talking cable that shall reach from the greatest city of the New World to the most beautiful one of the Old, and announce to our sister republic at the Paris Exposition, in 1900, that mankind has again bridged over space, and practically annihilated distance. Professor Thomson has already outlined a theoretically operative cable telephone system. The project contemplates practically two cables, a go and come line, or return circuit, and an arrangement of condensers placed at sufficiently short intervals to overcome the effect of static disturbances, which, in fact, is the most serious problem to be dealt with in any proposition involving long distance telephony. This is more particularly so in the case of a cable which it is impossible to suspend in the air above the water, but must lie practically in contact with the earth, being separated from it only by its own insulating envelope.

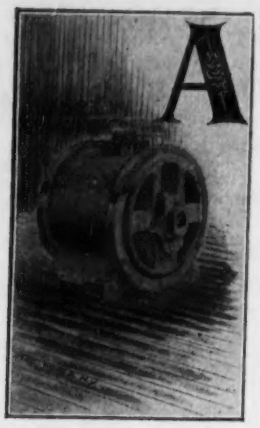
Aside from other considerations, such as the possible breakdown of the entire line, as a result of imperfect construction or accident to any of the condensers, the enormous cost of the Thomson system makes a discussion of it useless, excepting for the interest it presents to purely theoretical investigators. The automatic telephone repeater, which has borne the burden of the sneers and scoffs of so many electricians of note, would, it is freely admitted, if it were entirely practicable, open the way to an immediate consummation of the dreams of telephone cable experimenters.

There is no question in the mind of anyone who has given the matter serious attention, that if the telephone repeater can be made perfectly automatic, perfectly reliable, and withal, so simple in construction as not to require either frequent repairs or adjustment, it would of necessity do the work of repeating any distance, and there would be no limit to telephonic communication.

Furthermore, it is obvious that with such a system, a single wire would be entirely adequate for the transmission of a message, and, as experiments have shown, that speech is discernible over a hundred miles of cable, it would only require thirty odd repeaters along the line of an Atlantic cable to enable us to talk from New York to Paris, and bring the Old World that much closer to the New. Are such repeating instruments practical, or even possible? This question I am not prepared to answer to my own entire satisfaction at the present moment, but standing at the threshold of the new year, I wish to place myself on record as saying that I should not be at all surprised if, in the course of the next twelve months, announcement should be made that a successful invention of this kind had been given to the world. Moreover, I may say further, that I shall be almost disappointed if America does not announce over a telephone wire to Europe its latest supremacy in electrical achievement, and this to the assembled representatives of the scientific world which will gather at the great exposition in Paris. My prophecy is not based upon the mere generalization that "the theory of to-day is the fact of to-morrow," for I have personally received at the end of a third circuit a message which has been automatically retransmitted by two telephone repeaters connecting the three lines into one.

On the Use of Polyphase Motors on Electric Railroads.

BY CHARLES PROTEUS STEINMETZ.



AS far as I know no electric railroad using polyphase motors is in operation or in process of installation in the United States, but there are several in Europe. One installation, by Brown, Boveri & Co., has been in operation for some years in Lugano; another one is being installed at Varese, and on the projected road up the Jungfrau, in Switzerland, the use of polyphase motors is intended also. While the Lugano road represents an exceedingly light service, operating very small cars at slow speed over short lines, with no grades, switches or crossings, the Varese road will be an example of very heavy service, and so also will be the Jungfrau road.

No engineer familiar with the apparatus doubts that the polyphase motor can be used just as satisfactorily as the direct-current motor for the operation of railroad cars. The polyphase motor can give the same or even a more powerful start; can be used with series-parallel control for half-speed and full speed and rheostatic control for intermediate speeds, just as the direct-current motor can be, and offers over the latter the advantages that it can maintain its full speed, and thus the schedule time, even at over-loads, and that beyond synchronism and in tandem beyond half-synchronism, it returns power into the lines, thus acting as a brake.

The reasons which have thus far retarded the introduction of polyphase railway motors in this country are to be found in the enormous development of continuous-current railroading and familiarity with the rotary converter.

In Europe electric railroading is in its earliest development. The mileage of electric railways and the number of motor cars in operation, while considerable, are nevertheless insignificant compared with those in the United States. Thus the continuous-current railway motors are in Europe no more nearly standardized than the polyphase motor, familiar from its extensive application in factories, mills and workshops—while the rotary converter is almost entirely unknown. Hence, wherever the distance is too great for direct-current transmission, as when water power is used for generating alternating currents, it becomes natural to apply the polyphase motor directly to the car.

In the United States, however, direct-current railroading has been developed up to its minutest details, and every appliance used therein standardized and manufactured by thousands and ten thousands. The enormous advantage of using standard apparatus, which can be secured anywhere and from many manufacturers, and is necessarily cheaper than special machinery and more familiar to the user, almost always leads to the adoption of the former, even if the latter should do the work just as well or better. There are many instances where the power must be supplied to the railway system over a long distance, that is, as alternating current. Here, however, the rotary converter finds its application, and many such rotary converter installations for electric railroading are now in operation.

As a representative instance of a rotary converter system may be mentioned the St. Anthony Falls plant, while the Varese plant in northern Italy serves as an example of the application of three-phase motors to the railway cars.

To use St. Anthony Falls water-power for the operation of the railways of St. Paul and Minneapolis, seven generators of 700 kilowatts each were installed in the water-power station. Two of these generators are continuous-current machines, the other five are three-phase alternators wound for 3450 volts. They feed into the underground cables leading to the sub-stations in Minneapolis directly at the generator voltage, while to St. Paul the power is transmitted at higher voltage by the use of step-up transformers. Distributed over St. Paul and Minneapolis are six rotary converters of 600 kilowatts each, supplied by step-down transformers, and over-compounded to maintain constant voltage at their commutator brushes, irrespective of the load, by phase control. Since the transmission cables are of very low self-induction, three reactive coils are inserted into the circuit of each rotary converter, of about 30 kilovolt-amperes each, to supply the self-induction necessary for phase control. The two continuous-current generators in the power house and the rotary converters in the sub-stations feed into the same system of trolley lines covering the two cities. Railroad motors, cars and trolley lines are standard direct-current apparatus.

By the same manufacturer a three-phase railroad is being installed at Varese, in northern Italy. A number of 250-kw three-phasers, wound for 6000 volts, feed into the high potential line at 45 cycles. Step-down transformers distributed along the road supply the trolley lines at 500 volts. The road consists of two branches, one with grades up to 4½ per cent., and about 20 miles long, on which 26-ton trains will be operated at 22 miles per hour, and a short branch of 5 miles length, which zigzags up a mountain, with a continuous grade, varying from 6 to 7¼ per cent., for a distance of 4 miles, and numerous curves. Here it was important that the motors while going down the grade at half-speed should return power into the lines. Each car is equipped with two three-phase motors of 70 horse-power each. The motors are controlled by the tandem-multiple system, which gives similar advantages to the series-multiple system of continuous-current motor control. That is, at full speed the motors are connected in parallel with the three-phase lines. At half-speed only the first motor receives current from the lines, and the primary of the second motor receives current from the secondary or armature of the first motor. For this purpose the motor is supplied with collector rings and rheostats for use in starting, etc., just as in the series-parallel control of continuus-current motors.

The road is necessarily a double trolley road, the rails serving as the third conductor of the three-phase system.

While for this road the three-phase motor is specially suited, on account of its ability to return power when running above full speed in parallel connection and above half-speed in tandem connection, as when going down a grade, nevertheless in the United States the road would probably have been fitted out with direct-current machinery and rotary converters, that is, with standard railway apparatus.

For controlling polyphase railway motors three methods are available:

First—Rheostatic control.

Second—Tandem-multiple control.

Third—Potential regulation, with short-circuited motor armature.

First—In rheostatic control the armature or secondary circuit of the motor is supplied with collector rings, across which the rheostat is connected. A rheostat in the main or primary circuit would reduce the torque per ampere proportionally to the reduction of voltage, due to the decrease of magnetization of the motor, and thus this method is not suitable for railway work. The advantages and disadvantages of rheostatic control are the same as on the direct-current system. The system is very simple, and the motors satisfactory and efficient at full speed, but in starting and at low speeds power is wasted in the rheostat.

Second—Tandem-multiple control. Two induction motors in concatenation, that is, the secondary of the first motor feeding the primary of the second motor, reach their synchronous speed at half the synchronism of the alternating-supply current, that is at half the speed at which they would run in parallel connection. This method thus gives the same features as series-parallel control on continuous-current motors; that is, it approximately doubles the torque and saves the power wasted in the rheostat below half-speed and reaches full efficiency at half-speed. Obviously, just as in series connection of continuous-current motors, the efficiency at half-speed is not quite the same as at full speed and parallel connection, since with the same torque the losses in the former case are double. Still, the efficiency with this method of connection is far superior to that attained by rheostatic control, and the starting current is less, but the controller is somewhat more complicated.

Third—The potential regulator offers the simplest arrangement. The motor has no collector rings, but a short-circuited high-resistance armature, giving maximum torque in starting, and the torque and thereby the speed is varied by varying the impressed voltage at the motor terminals. This is done by a potential regulator; that is, a transformer, or rather compensator, of variable ratio of transformation. Unfortunately with such a motor the efficiency at speed is lower than when rheostatic control is used and the apparent torque efficiency, that is, the torque per ampere, is very low in starting. The motor requires in starting at least twice the current for a given torque that it would require with rheostatic control. Considering now that the starting torque of a railway motor must

be at least from two to three times the running torque, the starting current with the potential regulator method is about four to six or more times the running current. Since, however, the torque of the motor falls off with the square of the voltage, still more current is required in starting, on account of the drop of voltage caused in the lines by the excessive starting current. In consequence of this if the drop in the lines is not very small, even at heavy overloads, the motor is liable to be stalled or to fail to start. In consequence thereof the potential regulator control, while apparently the simplest, is entirely unsuitable for most railway work, or any other work where heavy starting torque is required and the supply of power is not unlimited as compared with the size of the motor.

Comparing the relative advantages and disadvantages of polyphase and of continuous-current motors for railroading, we have as the foremost and dominant advantage of the continuous-current motor that it is standard apparatus, familiar to and well understood by everybody, and capable, with the help of rotary converter substations, of use on roads at any distance from the power station.

It requires a single trolley only, while the three-phase motor requires a double trolley.

On long-distance roads, however, the continuous-current motor requires rotary converter sub-stations, which need some attendance, while the polyphase motor only needs stationary transformers distributed along the line.

In starting, acceleration, efficiency, etc., both types of motors are about equal. In operation the polyphase motor is somewhat more reliable, due to the main current entering the stationary member only, and to the absence of the commutator. This advantage of the polyphase motor, however, is probably about offset by the greater familiarity of most people with the direct-current motor.

With the same voltage the three-phase railway system requires more copper in the lines, since the drop of voltage with the same current and size of conductor is greater in the polyphase system, being the impedance drop against the resistance drop with the direct-current system. A lesser drop of voltage in the lines must also be chosen in the polyphase system, since the torque of the motor decreases with the square of the voltage. Since, however, the three-phase current enters the stationary member of the motor only, and no commutator is used, a much higher voltage can be chosen in the trolley lines of the three-phase road than is permissable in a continuous-current road.

In the continuous-current motor the speed varies with the load, while the polyphase motor can maintain its speed irrespective of the load, and is thus better suited to keep its schedule time under all conditions of traffic. Hence, it is preferable for long-distance or interurban roads with single-track lines. In the polyphase motor all difficulties with commutation are absent, and the structure of the motor is simpler, thus making it specially fit for heavy high-speed service, or for heavy service in general, as for hauling express or freight trains up grades, which are too steep for the steam locomotive to surmount them.

The Accumulator Industry in Germany.

As an illustration of how the accumulator industry is flourishing in Germany, we notice from the report of one of the large companies there that during the past year the amount of business done was nearly $1,500,000. The number of plants installed or in progress during the past year was 6132, of which a large number are central stations. One of the new directions in which accumulators are being used largely is in connection with power houses for electric railways, where they are used to equalize the load or as boosters. Quite a number of cars are also being equipped with accumulators, both for the ordinary system of accumulator traction and for the mixed accumulator and trolley system.

Electric Lighting in Japan.

Of the forty-two largest cities in Japan, from Tokio, with 1,368,000 population, down to those of 26,000, electric lighting systems are installed in twenty-four, eighteen being without electric lights.

Paradoxical but True.

An electrical engineer, being recently asked by a layman what a "dry battery" was, replied that a dry battery was so called because it was always wet inside, in order to distinguish it from a wet battery which may become dry.

Remarks Upon Long Distance Distribution for Electric Traction.

BY PROFESSOR ANDRÉ BLONDEL.

THE problem of the transmission of energy for long-distance traction is to-day of continually increasing importance, and it is interesting in this connection to see if it cannot be solved in certain particular cases by the aid of the ordinary continuous current. Up to the present there has been used for electrical traction only distribution of current in multiple, and it is this which greatly limits the employment of direct current. On the other hand, distribution in series, while tried in various manners, particularly in connection with telpherage, has not become a common method because of the extreme mechanical complications of the methods adopted, resulting in the employment of numerous commutators and interrupters, such as have been proposed by Perry, Cattori and others. If, however, this method of distribution could be simplified, it would present valuable advantages, and would without doubt, be susceptible of application.

The writer proposes to describe here a method which meets this suggestion, and which operates upon the principle of feeding the cars by a series distribution of constant current without the necessity of operating any switches or commutators upon the line by the passage of the trains.

THE PROPOSED SOLUTION.

This solution consists of the combination of a certain disposition of conductors in the simplest and clearest case, for one line a peculiar arrangement of the motors.

1. Disposition of the Conductors.—Fig. 1 represents the disposition of conductors in the simplest and clearest case, for one line of single track forming a closed loop. The generating station is

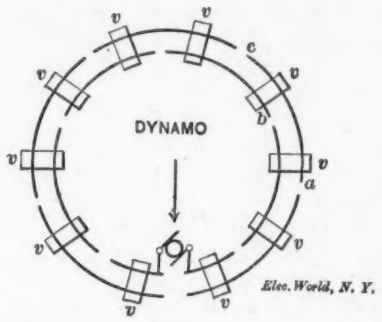


FIG. 1.

placed at any point upon it, and along the track two series of sectional conductors, of which all the sections are equal, are erected—these alternating their points of discontinuity, or, as it were, lap-jointed. We will call the part comprised between two consecutive joints, as *a b*, one section of the line. The two conductors are placed parallel to each other, either upon the tracks, or suspended above them, and all the sections are carefully insulated from one another, and, of course, also from the earth, in the usual way. At the breaks between the successive sections switches are placed, permitting them to be thrown together if it is desired to change the interval or headway between trains, as will be explained further on.

2. Method of Operation.—The trains should be distributed upon each pair of conductors in such a way that upon each section, *a b*, there will always be one train, *v*, which will thus provide an uninterrupted electrical circuit from one end of the line to another. The terminals of the conductor system are connected with a dynamo or a series of dynamos, giving constant current at variable potential. The system of dynamos and of regulation employed for maintaining this constant current could be any one of the well-known systems, notably the exceedingly ingenious method designed by M. Thury, and too well known to require any description here.

Each car or train absorbs an E. M. F. sensibly proportional to the work necessary for its propulsion, and the voltage at the ter-

minals of the dynamo is the sum of all these E. M. Fs. In this manner a whole line can be fed with a small current at a high voltage, thus permitting the employment of conductors of small cross section.

The difficulty, however, is in making the car pass from one section of the line to the following one without breaking the circuit, for in this case all the cars would immediately come to rest. To avoid this difficulty, a number of sections smaller than that of the equi-distant trains, as arranged by the schedule, is chosen in such a manner that at the time when one car quits a section another car has already certainly entered into this same section at its opposite extremity. For example, nine sections would be employed for twelve trains. In this way, each train which entered a section would have to travel over one-quarter of its length before the preceding train left it. It would only be necessary to instruct the drivers not to leave a section until after having been warned of the entrance of the following trains upon it by the amperemeter on their own main current supply, which would immediately indicate in this case a reduction of the current strength to one-half. When two trains are thus found upon the same section they were fed in parallel and run sensibly at the same velocity, since each receives only half of the current. The current tends at all times when the velocities are not equal, to divide itself between the two trains in such a way as to equalize their speeds, because the slower train opposes a less powerful E. M. F. to the

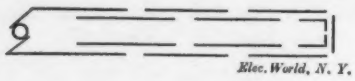


Fig. 2.

passage of the line current. To avoid the shunting of current from a car when another is started on the same section, it is only necessary to place the stopping stations at the middle of sections and not at their extremities, in such a way that each car would be alone in its own section at the moment of being put into motion. These conditions determine the method of operation. While the cars are standing still the motors are, of course, short-circuited, to allow the passage of the current.

3. Disposition of the Motors.—The momentary reduction of current to half of its normal value during one-quarter of the run on any section would probably entail a slowing down or even a stoppage of the cars, if it were not possible to artificially remedy this condition. This is done by the employment on each train of several motors, distributed in groups of two, or of two-winding motors, which present the same properties. Then, by putting the two motors of each group, or the two armature windings of each double-wound motor normally in parallel when there is only one car in a section, and in series when there are two, the motor effort will remain exactly the same in the two cases, only the voltage in the section would be momentarily doubled by putting the motors in series. The change of connections in the motors woud be made by hand with a controller analogous to existing types. Each time the driver saw the needle of an amperemeter or of a current indicator placed before his eyes pass quickly from one to the other of its two normal positions, he could properly handle the series-parallel controller. This could even be worked automatically by the aid of a coupling switch operated by an electromagnet working in opposition to a spring, this taking two different positions according to whether the current was at the one or the other of its two values.

The regulation of the motors is accomplished as in all constant current motors, that is to say, by changing the point of application of the current to the armature inductors (brush shifting), or by shunting the exciting current through a resistance. The motors would be calculated to carry normally about half the current. They could then carry the total for some minutes for starting or for excessive effort when they are put in series.

Up to this time we have considered the case of a loop line having a simple schedule of cars operating in one direction around it. To supply trains running the other way, the best solution consists of adding another track, and arranging for this a second group of generators and a second series of conductors, independent of the first. By choosing a number of sections equal to the number of trains operating simultaneously in the same direction, and regulating the schedule so that upon each section the trains do not pass in the middle, but toward one of the extremities, it is possible to feed the incoming trains by the same conductors which carry current to outgoing trains. This method of operation, however, is much less convenient than the preceding, and should not be insisted upon.

The case of an unlooped line extending from the station to another point can be made into that of a looped line in the following ways: (1) If the installation consists of two tracks, the two can be considered together as forming a flattened loop, Fig. 2, and along each of them can be disposed a series of sections, of which all the conductors form together a continuous circuit for the use of the cars. (2) If the installation is a single track, the same system of four conductors can be still employed by making all the cars going in one direction operate upon two of them, and all the cars going in the other direction operate upon the other two. If it is necessary to feed a more complex installation, it can always be reduced to a certain number of loop circuits or of simple lines by treating each one as above and grouping the generators.

CHANGING THE HEADWAY OF TRAINS.

In the system just described the number of sections is related to the number of trains in movement, but the number of trains can be modified to suit any exigencies by the aid of one of the following methods: (1) The constant intensity of the current can be modified without changing the number of sections. For example, if, at a given moment, it is desired to double the frequency of the

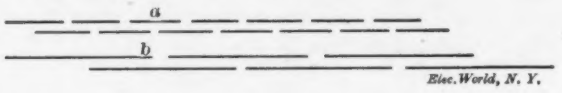


Fig. 3.

service by putting on twice as many trains, this would normally put two in multiple on each section. Under these conditions, when a train is stopped it should not be short-circuited, but cut out of circuit. Each generating unit should be replaced by two in parallel, care being taken to mechanically couple the dynamos thus joined in circuit. (2.) By the use of switches, conveniently placed in the conductors, the length of the sections can be changed. For example, if it were desired to work on the same line a service of five minutes' headway and then of fifteen minutes' headway, the sections would be constructed with reference to the former schedule, Fig. 3, *a*, and to meet the demands of the second it would only need to join in groups of three the sections of each of the conductors, Fig. 3, *b*. If a ten-minute headway were desired, sections divisible in half would be employed, and these grouped three by three, etc. The manipulations necessary could be made by the station or signal-tower men in a way similar to the present handling of switches. These manipulations would not have the effect of stopping the line, for it would only need to open and close each switch at the moment when the last train of a given service had passed the station. If it were desired to change the service from five minutes' headway to fifteen minutes' headway, the switches which connected the sections in pairs would be closed when the last train of the five minutes' service (just before the beginning of the fifteen minute service) had passed this switch. For an inverse arrangement the switches are opened the moment after the last train of the fifteen minute service passes them. (3) It is possible, finally, to combine the two preceding methods or employ one of the other or both of them, according to circumstances.

ADVANTAGES OF THE PROPOSED SYSTEM.

The first advantage of the new system is common to all series systems. It is the saving in the price of conductors compared with distribution in multiple at 500 volts. This saving, even when reduced by the employment of two parallel conductors in place of one, with the track as a return, as in the multiple system, is still very marked, since the fall of potential can allowably be very great. For example, eight cars, each requiring 500 volts and 20 amperes on the double track line, with the station at one extremity, would operate on 4000 volts total tension and 20 amperes of constant current. The line would then require one-half less copper than in a distribution in multiple, where the eight cars consume together a maximum of 160 amperes, and a mean of 80 amperes at 500 volts. This advantage could be much further augmented if the tracks could be insulated from the end and divided into insulated sections for their utilization as conductors. In the

case where the track is not insulated, it would be necessary to insulate in the best possible way the apparatus and the operator upon each car, so that the total difference of potential existing between the line and the earth might not affect them.

In addition, the feeding of motors in series presents advantages from the point of view of their operation. Receiving always a constant current, even at the moment of starting, the regulation of the speed of the motors is accomplished without any interposition of resistance in the circuit, by reducing the number of field turns traversed (by shunting them with an external resistance). The waste of energy and losses which accompany the employment of resistance at the moment of starting motors fed at a constant potential is thus avoided. As it is never necessary to break the current (except in a particular case when the number of trains is doubled, and it can even then be avoided), but since, on the contrary, when it is desired to stop the car, the motors are short-circuited, no arc can be formed in the controller. This can be considerably simplified and its cost materially reduced.

CONCLUSION.

The system of series operation which has been described possesses a flexibility less than that of the mulltiple system, but nevertheless sufficient for many applications. Naturally one would not care to apply it to a tramway service, but it seems possible for employment upon lines which do not use the surface of the streets, and which operate a considerable number of trains, where the high voltage, which is an essential condition to economy in transmission, can be used.

As an illustration, by employing motors taking 500 volts each, eight trains can be properly operated in series at 4000 volts. The most important case of its application would be long-distance and surburban lines, above all those frequented by tourists, metropolitan underground and elevated lines, and, eventually, telpherage lines of great length. Now that the question of metropolitan there will be some trial made of such a method as this before enlines possesses so continually increasing an importance perhaps tering upon the complication and the excessively high expense resulting from the employment of transformer sub-stations fed by primary tri-phase lines at high voltage. The writer of this article cannot conceal from himself the objections which can be made to this system for practical work, of which he has himself indicated the principal ones, but whatever the defects, he will be happy if he should have introduced some new ideas on this question by showing that, outside of the ordinary solution, or the employment of polyphase motors, there yet exist other processes more or less imperfect but sufficiently interesting to deserve being brought to the attention of specialists more competent than himself to discuss his subject.

The Utilization of the River Arc.

The Arc is a torrent of an Alpine valley in France, fed by large fields of ice and snow. The amount of flow varies between 10 and 250 cubic yards per second, with a mean of from 23 to 35 cubic yards a second. In its upper part the stream operates a number of saw mills and other small powers, and a paper factory at Modane. The first important work, 3 miles below Modane, belongs to the Société des Forges. Here aluminum and carbide of calcium are manufactured. The present power consumption at this works is 3000 horse-power, and this will shortly be increased to 13,000 horsepower. One of the dynamos installed at this point merits special mention, being the most powerful unipolar continuous current machine ever constructed and working under the highest tension. Its output is 15,000 amperes at 40 volts. About two and one-half miles further down stream there is an electro-chemical works for the manufacture of chlorates of potassium and sodium and calcium carbide. At this point sixteen turbines operate sixteen Thury direct-connected dynamos, the total mechanical power absorbed being 4000 horse-power. Further down the Arc is the Calypso works, which utilizes a mountain torrent known as the Valoirette. At these works two dynamos producing direct current of 6000 amperes each at 150 volts are used for aluminum manufacture. The present installation amounts to about 3000 horse-power, but an addition of 12,000 horse-power is planned, and this will work under the enormous head of 1850 feet. The three installations mentioned utilize altogether 10,000 horse-power, and contemplate utilizing 32,000.

Some Difficulties of Heavy Electric Railroading—I.

BY LOUIS BELL.

HAVING many times gone squarely upon record as a believer in the future of heavy electric traction, the writer has earned the privilege os speaking his mind freely concerning its possible limitations.

So much has been said through so many varieties of hat touching the infancy of electric traction, that the dear public has been almost persuaded that the locomotive is already ticketed for the scrap heap, and is very shortly to be replaced by electric motors, which consume no power to speak of and never wear out. This cheerful belief is not unwelcome to those who manufacture and install electrical machinery, but, in the long run, honesty is the best policy and the real interests of electrical progress will be better served by pointing out than by ignoring the difficulties that must be overcome.

The path of the electric street railway from the beginning of fifteen years ago to the triumphant success of to-day has, it is true, been marked by a splendid series of victories, but it is also dotted with defeats and strewn with wrecks. The huge scrap heaps of early manufactories, now half forgotten, and the grim record of receiverships bear witness to the asperities of the way and the obstacles now happily surmounted.

Through all this much has been learned, so that, as regards methods and apparatus, future progress is comparatively easy, and the failures of a decade since are not now within the bounds of reasonable probability. But the future will inevitably bring its own peculiar difficulties, some trivial, others formidable, and the more clearly these are recognized and evaluated, the more directly and successfully can they be attacked.

Now in the first place, from a general point of view, the steam locomotive is a remarkably good prime mover, quite comparable in its economy with all except the best stationary engines. What it loses through crude valve gear it in large measure regains through high speed, high pressure, and large capacity. In fact it can and does produce power more efficiently than the ordinary single valve engine, say at an expenditure of 25 to 30 pounds of steam per hp-hour, corresponding to from 4 to 6 pounds of coal. Consequently, if we attempt electric traction with steam as a prime mover we must be able to generate power very cheaply indeed to be able to stand the losses in the generators, lines and motors without actually incurring a larger fuel bill than would be entailed by the use of locomotives, to say nothing of fixed charges due to the electrical investment. In other words, the margin of economy between locomotive and other large engines is too small to permit any considerable electrical losses of any kind. It therefore appears at the outset that the question of relative economy will turn largely upon the efficiency of the line and motors, hence upon the service and the distances involved. There is no better way of making clear this phase of the question than the examination of a concrete case, taking as an example a certain large railway system and looking into the conditions of economy that must be fulfilled if the same service were accomplished electrically.

The road in question is more than usually favorable to electric traction in the comparison, because the cost of fuel is high, $3.50 per ton. In the first place, it is worth while to note that the main saving of electric traction is the reduction of the fuel bill, which is only a trifle over 8½ per cent. of the total annual expenditure. Any saving effected in this item is therefore necessarily a very small part of the total cost of operation, however desirable it may be in itself. The road burns annually about 500,000 tons of coal, costing about $1,750,000. How much of this could be saved by adopting electric traction on its 2800 miles of track, and at what cost? Remember that we are not starting *de novo* to build a new system under ideal conditions, but are taking things as we find them, as engineers will generally have to do in the future. We shall be quite safe in assuming that in the locomotives we can obtain one hp-hour for the consumption of 5 pounds of the good quality of anthracite which is used, costing in this case 0.8 cents, or say 1 cent for each hp-hour at the draw-bar, including all losses. This corresponds very closely to the general average of

proper required in ordinary railway work, and the known cost of fuel per train mile. Now, how much fuel wil be required to deliver one mechanical hp-hour at the car axle with electric traction? One must first form some idea of the number and size of the stations which it will be possible to employ. The total length of road involved is about 1700 miles and, estimating the output from the coal consumption, about 300 hp-hours per day per mile of road is the amount required. Even assuming one station per 100 miles of road, which involves a power transmission problem not yet fully worked out, and assuming high tension alternating current delivered directly to the locomotives, an experiment yet untried, seventeen power stations would be needed, each of an average output, *delivered at the wheels*, of 1500 horse-power. The most optimistic estimate of load factor can hardly exceed 75 per cent., *i. e.*, 2000-hp capacity at the wheels, as before, and 3000 is a far more probable figure, judging from railroad schedules. Now to deliver this power at the wheels still greater capacity is required at the station. The combined efficiency of engine and dynamo at the load factor in question may be safely taken at 80 to 85 per cent.; the line at perhaps 90 per cent., and the motors at possibly 80 per cent. In all there would be small hope of more than 60 per cent. efficiency from indicated horse-power at the engine to the car wheels. This means that for each horse-power delivered 1 2-3 horse-power must be generated, *i. e.*, the full capacity of each station would average about 5000 horse-power. Now under very favorable circumstances one would have to allow with the above load factor surely 2 pounds of coal per indicated hp-hour, or 3 1-3 pounds per wheel horse-power, costing at the assumed price of coal about 0.53 cents as against about 1 cent on a very liberal estimate, for the locomotive. For the road in question the fuel bill would then amount to about $927,500, a saving of $822,500 annually. Against this we have to set off the large increase in fixed charges, due to increased investment. It is possible that the conductors might be erected for $3000 per mile of track, for a transmission at not less than 10,000 volts; this would mean an investment of $8,400,000 for this item. Next come the seventeen stations, each of 5000 horse-power. These would cost, taking figures from first-class modern stations of this capacity, about $300,000 each, making $5,100,000 more. The railroad system we are investigating has at present 665 locomotives, and, as railroads are not in the habit of purchasing locomotives for fun, it would hardly be safe to allow fewer electric locomotives of their equivalent. Of course, one's first thought is that owing to the increased daily mileage which can be secured by electric traction the 665 locomotives in question could be replaced by a much smaller number of electric units. The locomotives on the average ran about 70 miles per day. But the actual number necessary depends on the exigencies of scattered service more than on any intrinsic limitation on the daily run, and we have as yet no data on the safe daily run for electric locomotives, that run which can regularly be made without paying dearly for it in repairs.

If instead of electric locomotives one passes to motor cars forming individual units the cost of equipment will be greatly increased, and except for suburban traffic the increased earning capacity is of dubious value. The backbone of a railroad's gross receipts is the freight traffic, and this cannot be materially increased by changes of schedule, while subdivision of trains, whatever the motive power, will increase the cost of haulage. The cost cannot safely be taken as less than $10,000 each, making $6,650,000 more. Summing up these various items we reach a total of $20,150,000, which at 4 per cent. means an annual interest charge of $806,000. This leaves electric traction $16,500 per annum ahead of the game, *plus* whatever it can gain on repairs, and *minus* the added maintenance and depreciation charged off against the station and line equipment.

The repairs on locomotives are rather heavy, not far from 8 per cent. of their cost, amounting on our typical road to about $400,000 per annum. It is quite reasonable to suppose that repairs to large electric locomotives would be less than this, not over half perhaps, by reason of a far less number of moving parts. Also, there is reason to expect somewhat less depreciation than in an ordinary locomotive. Taking these items into consideration the margin in favor of electric traction might reach $300,000. But the stations and lines are subject to depreciation also, and, taking it even as low as 4 per cent., the counter charge amounts to $540,000 annually.

The labor item is not altogether easy to evaluate without data derived from experience, but one can say with certainty that about twenty men would be required to secure continuous operation of each of the seventeen power houses, working in three shifts. This is derived from the force actually required in large street railway stations with modern apparatus. This makes a total of 340 for the power houses. Add to this battalion the force required for proper continuous inspection of the working circuits on 1700 miles of track, and the total easily offsets the possible saving to be made by dispensing with the firemen. In point of fact, in much passenger service running with only one skilled man in charge of the motor power would be somewhat hazardous.

There has been as yet no organization of operating force for a large electric railway system of the sort we are considering, but in the writer's judgment such a force would have to be at least as large as that on an ordinary railway operating the same track. Comparisons with electric elevated roads are not here in order, because such roads do not involve numerous power houses nor hundreds of miles of track, but are so compact as to give electric traction an advantage which it has not, and in the nature of things never can have, in connection with diffused and varied traffic on a great railway system.

Figure as we may no plausible supposition can give electric traction, even under conditions of distribution as yet far from realized, any material advantage in the general case of duplicating the whole service of any of our large existing railway systems. And yet a glance at the figures shows that the main difficulty under which electric traction labors is in the prodigious cost of the distribution over an immense mileage, and the cost and waste in numerous large stations rather lightly loaded. With a dense traffic, such as is found in compact suburban systems, enabling a heavy and fairly uniform load to be kept on one or two large stations, the cost of fuel per hp-hour *at the wheels* may fall as low as 0.25 cents or even 0.2 cents, which puts a very different complexion on the matter, and transfers the balance to the right side of the account. Colonel Heft gives 0.32 cent and 0.42 cent at New Britain and Nantasket respectively per hp-hour at the station when burning coal, and 0.19 and 0.21 cent when burning "sparks." Moreover, under such circumstances, the fixed charges become relatively low and experience shows that the traffic is likely to still further increase. But while in such cases and in special problems, like elevated roads, underground roads and tunnels, there is every reason to believe that electric service is both economical and in every way advantageous, the general work of American railroading, with its long runs through sparsely settled districts, its branch lines with no call for more than one or two trains per day, and its tangled and troublesome local freight service, from which a large part of the revenue has to be derived, is, and is likely long to remain, the special stamping ground of the locomotive.

For the present the attention of electrical engineers should be concentrated on overcoming difficulties to be met in the compact urban and suburban rapid-transit systems, for although the way is comparatively clear in this line of work there is still opportunity for the display of skillful engineering. The ideal form of working conductor for this class of service has yet to be devised, and until it is forthcoming and an adequate feeding system is worked out, much is left to be desired. In particular, there is need of such a feeding system as to obviate the very serious danger of a general breakdown of the system from a single accident.

Boston has just been treated to a fine exhibition of the lack of independence inherent in electric traction, when a single grounded cable paralyzed the major part of the West End system for four hours, in spite of its five power stations and network of feeders. The possibility of such accidents is the weakest point of electric service on important systems. It is bad enough on street railway systems, like the West End, which are to a considerable extent paralleled by the suburban railroads, but if one of the latter should break down, stopping traffic into the distant suburbs at the hours of densest travel, it would be a far more serious matter. Fancy, for example, the entire suburban service of the D. L. & W. R. R. breaking down at 5:30 some evening for the night! At present about the worst that can happen is a ditched train, which seldom delays traffic more than an hour or two, but with electric service the whole line is likely to go together. This contingency must be guarded against at almost any cost. It should certainly be reckoned as one of the most serious difficulties in the extension of electric traction in competition with steam.

Recognizing this obstacle, it is not at once obvious how it can be overcome. It is inherent in any system operating a considerable extent of road from a single station, and is in fact part of the price paid for that centralization which makes electric traction economical

It is, you may say, the penalty for putting too many eggs in one basket. In fact, it forms a very serious objection to the operation of any important suburban system from a single station, and implicitly to the sometimes very desirable procedure of transmitting power to sub-stations. In these days it is sometimes necessary to guard against both accidents and malicious interference, and in view of all this it is best to restrain one's very natural desire for concentration and operate from distributed stations with plenty of reserve capacity. This is often in reality cheaper than working a transmission system with a resulting loss of 20 or 25 per cent. of the energy, and it is always safer.

However these stations are situated, their feeding systems should overlap in such wise as to enable them to give mutual assistance when needed.

It is now possible to secure generators that will deliver either alternating or continuous current as desired, or serve as rotary converters, and thus it becomes quite possible to interconnect a pair of stations so that in case of an accident to one the other may be able to come to the rescue with its spare machines, or even deliver power at some point along the line by means of a spare rotary converter.

It goes almost without saying, that besides these special precautions, great care should be taken in planning the feeder system of suburban lines, so interweaving them that the effect of a single break or ground will produce as little trouble as possible. As regards stations, the general rule should be to so arrange them that no breaking down of a single station can cripple any considerable part of the system, and the same consideration applies to the feeders.

Passing by this general question of security of service, which is one of the gravest matters connected with the extension of electric traction, into the field now occupied by ordinary railroads, it is worth while to look into some of the specific difficulties which must be conquered. Foremost comes the matter of voltage. At present nearly all railway apparatus is intended to work between 500 and 600 volts , the pressure generally employed for street railway work. This is all very well for short distances, but the area which can be covered at this pressure, without prohibitive expense for copper, is quite limited. The limitations are severely felt even in case of the relatively small power required in interurban street railway work, and as the units grow larger and more numerous a point is soon reached where distribution from a single station, or even two or three stations, involves very heavy expense. It is not putting the matter too strongly to say that if we are to be limited to say 600 volts as the pressure used in the distribution of energy, heavy electric railway work will very soon come to a standstill, except in lines in which economy of power is a subsidiary matter. This may be taken as the condition of things in elevated railways, for it is very doubtful whether even a board of aldermen can be found so venal and so dead to all hope of political future as to dare permit steam locomotives to be used on another elevated road.

To a considerable extent this also applies to strictly suburban service over moderate distances. It is beyond question that in the present state of rapid transit facilities around our large cities, the adoption of electric traction with trains running on short headway will produce a great increase of traffic, which might well repay a very heavy investment in copper, one quite unjustified by any direct saving due to electric traction. It is in the extension of these special cases, now admittedly a fair field for electrics, to the general case of suburban traffic that the trouble comes—trouble from which the most roseate views of increased earnings cannot distract our attention. There is a vast and vital difference between working out a beautifully elaborated *avant-projet* and paying the bills for the electrical equipment of a few hundred miles of track.

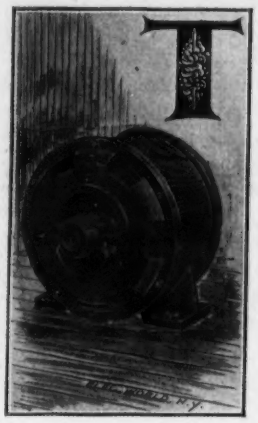
(To be continued.)

Programme of the Meeting of the Northwestern Electrical Association.

At the sixth annual convention of the Northwestern Electrical Association, to be held at the Hotel Pfister, Milwaukee, Wis., commencing on Wednesday morning, January 19, the following papers will be read: "Practice or Theory," "Present Efficiency of Incandescent Lamps," "Notes on Municipal Ownership," "Physical and Chemical Properties of Volatile Oils in Boilers," "Electric Lighting for Profit," "Long-Distance Transmission," and "Transformers." An enjoyable pleasure programme will also be provided.

Some Applications of Alternating Motors.

BY ALBERT GOULD DAVIS.



THE development of the alternating-current motor has now proceeded to such a point thit it has become a standard piece of electrical apparatus. But this does not mean that it can be installed recklessly, as it were, to replace any direct-current motor, or other source of power, doing any work whatever. Each type has its advantages and disadvantages. Among the more prominent advantages of the alternating motor may be mentioned, first, the absence of the commutator, and, with certain types, absolute freedom from sparking. It was this advantage which Tesla appears to have had in mind when he made his original invention. The avoidance of the commutator is of particular importance in certain special cases, as, for example, in certain classes of mines and factories. For example, the Tide Water Oil Company, of Bayonne, N. J., has been operating for two years a three-phase plant, comprising fifteen motors, from 2 to 30 horse-power each, aggregating 129 horse-power, in addition to a number of incandescent lamps. Some of these motors are placed in an atmosphere full of oil vapor, such that any sparking might cause a very serious explosion. A special type of oil switch is used, and the system has been entirely satisfactory. The engineer of the company informed the writer, a year ago, that he had concluded that the danger of sparking was entirely obviated, and now had no fear on that score. Among other things he said:

"This plant is operated 23 2-3 hours out of 24, seven days in the week, and up to this time we have not had a single stop or shutdown, due to any defect or deficiency in electrical apparatus.

"As to economy we estimate that we get our power distributed at from ¼ to 1-3 of what it cost us when conveying steam to widely separated engines. As to convenience it is ahead of any other system known to the writer. One great factor in utility and convenience is that by the use of our wattmeter we can, in five minutes, measure the exact amount of power being used by each motor, under the different conditions in which it is used; and I am thus able to charge the different departments with their proper proportion of cost, with no long operation of figuring up cards and estimating losses by condensation, etc., etc.

"To sum it all up, we find it perfectly safe, entirely reliable, very economical, and are pleased with it in every respect, so much so that we want more of it."

This letter is really an excellent statement of the advantages of electrical power distribution, and particularly multiphase power distribution, and puts the case very well. Direct-current motors would obviously have been out of the question in the particular relation in which these motors are used.

Another advantage of alternating motors, an advantage, however, which is only apparent in certain special uses, is their tendency to maintain constant speed at all loads.

A third advantage, and the one of the greatest practical importance, is the economy with which alternating currents can be transformed to high potentials and distributed over considerable distances.

It may be added to all these advantages, that the multiphase motors are simple in their mechanical construction, solid and strong, and about as efficient as the best direct-current motors. They may be built for very high voltages directly.

On the other hand, the alternating motor fails at one point. It does not permit, naturally, of easy speed regulation.

It is apparent that, as the art is at present developed, each type of motor has its own special uses. If 5000 horse-power is to be transmitted 10 miles, alternating machinery must be used. If the motor is to run in coal gases or oil vapors, again alternating machinery must be used. If the motor is to run long hours under the care of workmen without intelligence enough to adjust brushes, or if it is to run at a constant speed at all loads, the alternating machinery is decidedly preferable.

On the other hand, direct current motors are still used for all purposes in which a wide range of speed is desired, especially when

the wide range of speed is needed in combination with high starting torque.

The most striking example of this latter condition is, of course, the electric railway. In many electric railways we require the generation and transmission of thousands of kilowatts of activity and its distribution to a number of motors or sets of motors, whose maximum torque is required at the time of starting, the very point where a well-designed multiphase motor practically refuses to give any torque at all. The problem has been met in commercial practice in this country, as stated by Mr. Steinmetz in his article in this present issue, by multiphase transmission with rotary converters delivering direct current at 500 volts to the trolley wire. But the present writer cannot help regarding this device as a makeshift and a rather clumsy one, in spite of the brilliant manner in which it has been developed by Mr. Steinmetz and others. Here we have, in the multiphase motor, a simple, light, powerful, and efficient machine with no commutator and no brushes, and, if preferred, without even sliding connections. Yet the present American practice tends toward abandoning this motor for the most important use to which electromotive power, in the present and probably in the future, is or can be put in favor of the better known direct-current railway motor—a machine having no better efficiency, more expensive to build, and far more likely to get out of order. Not only this, but the present practice sacrifices economy. The writer is familiar with one very large electric railway, built at a cost of considerably over a million dollars and considered by most engineers a very well-designed and well-constructed plant, in which the average voltage drop from the generators to the motors is stated to be over 40 per cent. And this though the generating station is well located, and though the feeders are heavy and expensive. The writer is not sufficiently familiar with street railway practice to state how far this experience is repeated in the various railroads in the country, but he believes that it is something which is altogether too common. And indeed it must be. Suppose a railway whose power station is five miles from the centre of the system, requiring 2000 kilowatts at the motors, and let anyone calculate for himself the amount of copper necessary to transmit the 2000 kilowatts even to the centre of the system, and the difficulty will at once become apparent. Five hundred volts is not a suitable pressure for power transmission, and yet it is evidently about the limit for direct-current work.

The use of multiphase transmission with rotary converters in the sub-stations greatly reduces this loss. But, though the American rotary converter is a very perfect machine, it still has a far lower efficiency than that of the stationary transformer. In addition, such machines must be located in several buildings necessarily placed in the heart of the city, where land is expensive, and must be attended by skilled dynamo tenders. On the other hand, the stationary transformer is the most perfect of all electrical translating devices. It has an enormously high efficiency, requires no attendance beyond an occasional inspection, and can be placed on poles, or even underground if properly ventilated, or in any other convenient location.

The unbalancing troubles of the multiphase system promised a few years ago to be very serious, but do not seem to give any great trouble at present in well-designed installations.

It then becomes apparent that the only thing necessary to bring about the general introduction of alternating apparatus in railroad and general distribution is the production of an alternating motor which shall be self-starting under load and shall run at reasonably good efficiency at all speeds. But it is just here that the alternating motor naturally fails. In considering the question of speed regulation of alternating motors it is convenient to consider the multiphase machines first, and for the present purpose we need not consider synchronous apparatus, since such apparatus is, in general, not self-starting under load.

The writer, in an article in The Electrical World of December 12, 1896, divided devices for the speed regulation of electric motors into two classes: First, where the regulation is external, and, second, where it is internal. The external methods were discussed in that article, where it was shown that external regulation depends on the presence of a high resistance secondary. But such a secondary necessarily makes the motor inefficient. It is well known that the maximum theoretical efficiency of a direct-current motor is equal to the ratio between the counter-E. M. F. of the motor and the E. M. F. impressed upon its terminals. It is also true that the maximum theoretical efficiency of an induction motor is equal to the ratio between its actual speed and its so-called theoretical speed; that is, the speed corresponding to synchronism. Therefore if, by any method of external regulation whatever, we reduce the speed by any desired amount we also reduce the efficiency in the same proportion. In addition, the peculiar form of the speed-torque curve of an induction motor, having a fairly low resistance secondary, is such as to make these systems of regulation exceedingly objectionable.

As the more important methods of external regulation were considered in the article above mentioned it is only necessary to deal here with the systems of internal regulation, which may be roughly classified as follows:

First.—Variation of the resistance of the induced member.

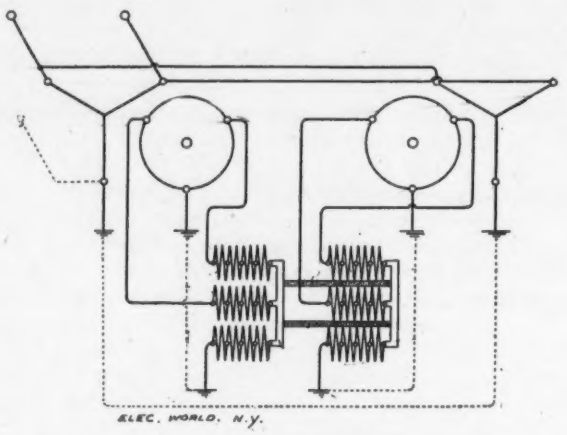
Second.—Variation of the reactance of the induced member.

Third.—Conjunction and opposition connections in the induced member.

Fourth.—Series multiple connections of the inducing members.

Fifth.—Tandem multiple connections.

The first of these methods, variation of the resistance of the induced member, is the one first proposed and the one first used. It gives flexible control, but is inefficient for the reasons stated above. In addition, it requires, on large machines at least, an external armature, or else a resistance coil moving with the induced member, since otherwise the variations of resistance, caused by the very slightest jarring of the brushes which collect the current from the induced member and carry it to the resistance coils, will be sufficient to render the torque very irregular.



Resistance Control of Two Three-Phase Motors.

In considering the second method, it is obvious at once that the insertion of a choking coil in the induced member is impracticable, since such a choking coil will cause the armature magnetism to lag so far behind the field magnetism as to greatly reduce the torque.

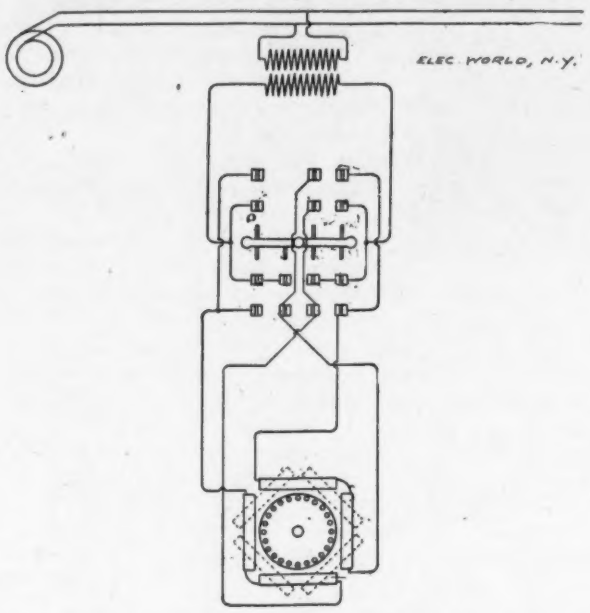
Charles S. Bradley has worked out a motor, very interesting in theory at least, in which condensers inserted in the secondary circuit are so adjusted as to render the secondary system resonant at all speeds. The frequency of the current in the secondary of an induction motor is equal, in a motor with a single polar line, to the number of alternations per second of the primary current, minus the number of r. p. s. of the motor. If, now, the secondary system be rendered resonant for any particular frequency, the speed of the motor will tend to come to a value corresponding to a current of that particular frequency in the induced member. Mr. Bradley stated to the writer some months ago that tests of this motor had shown very satisfactory results, and that the efficiency was good at all speeds.

Third.—Conjunction and Opposition Connections. The principle of this regulation, which was originally invented by Arnold, in Switzerland, and worked out by Bradley and Hunting in this country, consists in reducing the current in the secondary member at starting by connecting some of the secondary coils in opposition with others of the secondary coils, so that the difference of the E. M. Fs. induced in the two coils will work through the sum of their resistances. This method is obviously open to some of the objections urged against the resistance control, and does not seem to have come into use.

Fourth.—Series-Multiple Regulation. It is obviously possible to connect the two inducing members of two motors in series at starting, and in multiple with higher speed is desired. It is also possible to connect two or more inducing coils on the same motor in the same way. This idea was conceived and developed by Dr. Louis Bell, but it does not appear to have come into practical use. It obviously re-

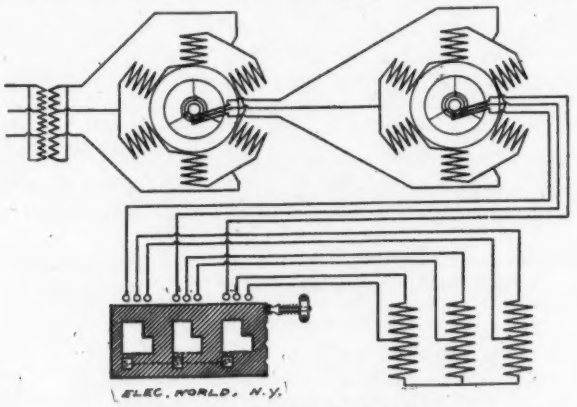
quires a high resistance secondary for its successful operation, owing to the form of the torque curve.

Fifth.—Tandem-Multiple Control. This, the most promising of all systems of alternating-motor control, appears to have been invented independently, at about the same time, by Goerges, in Germany, and by Steinmetz in this country. The Steinmetz patent is No. 587,340, dated August 3, 1897, on an application filed November 3, 1893. The gist of the invention lies merely in taking the low frequency currents



SERIES PARALLEL CONTROL OF PRIMARY WINDINGS OF SINGLE-PHASE MOTOR.

induced in the secondary member of an alternating-current motor running, for example, at one-half speed, which currents will then have one-half of the frequency of the line currents, and using them to drive a second alternating-current motor instead of expending them uselessly in feeding a resistance, as in the resistance control above mentioned. In the starting position the primary of one motor is connected directly to the line, while its secondary is connected to the primary of a second motor, mounted on the same shaft or driving the same machinery. For example, one motor may be mounted on each axle of a street car. Under such circumstances the maximum theoretical speed of each motor is one-half that of a similar motor

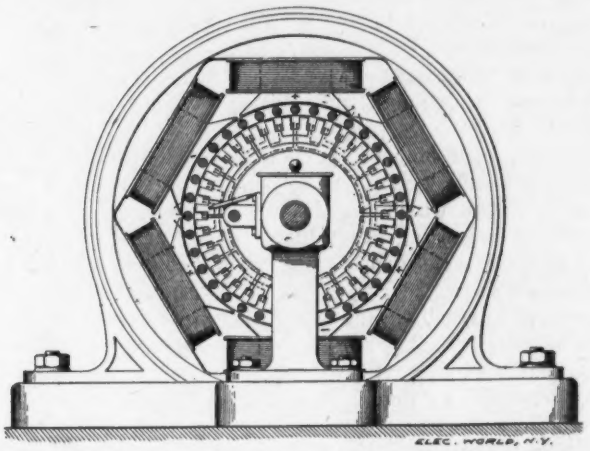


TANDEM-MULTIPLE CONTROL.

directly connected to the same line, and at that speed very high efficiency may be developed. Still lower speed may be procured by interposing resistances or other regulating devices in the secondary of the last motor, and Mr. Bradley has suggested that condensers may be inserted in place of the resistances, giving at once the good results of his resonance regulation, above described, and of the tandem regulation. When higher speeds are wanted it is only necessary to connect each of the two motors directly to line, with or without suitable resistances in their secondaries. We have here a system of motor control for alternating-current machinery fully equal to the well-known series-parallel control in direct-current work. The practical tests, so far as the writer is aware, have been fairly satisfactory. But if the tandem connection is carried too far; that is to say, if too many motors are placed in tandem, and, indeed, even where only two motors are placed in tandem, it has been found that the primary of one motor imparts to the secondary of the next preceding motor a large self-induction which greatly reduces the torque of the first machine. Not only this, but that winding which is best adapted to serve as a secondary winding for the first motor in the tandem position, and to generate current suitable to be transmitted through sliding connections or otherwise to the primary of the next preceding motor, must necessarily be a high-resistance winding, since it must generate a voltage much higher than that generated in an ordinary low resistance secondary in order to produce a current of some reasonably small volume in the intermediate connections.

The present writer has devised various means for overcoming these difficulties more or less completely, which methods are described in his patents 587,937, August 10, 1897, and 594,779, November 30, 1897. The whole matter is at present being rapidly developed, and it is impossible to state exactly what course commercial practice will take.

For elevator work the same difficulty presents itself as in railroading, that the motors have to be started and stopped frequently and rapidly. The alternating practice in elevator work is perhaps less developed than in railway work, owing to the fact that the engineers of the various elevator companies, though skilled in direct-



HUTIN AND LEBLANC SELF-STARTING SINGLE-PHASE MOTOR.

current work, are comparatively unfamiliar with the rather obscure actions of alternating currents. As an illustration of this it may be mentioned that something over a year ago one of the largest and most prominent of the elevator companies purchased a few multiphase motors for experimental purposes. The standard direct current control of this company is rheostatic, that is to say, a dead resistance is inserted in series with the motors. This method, though obviously exceedingly wasteful, and far inferior, in theory at least, to the system set forth in Leonard's patent, No. 572,903, December 8, 1896, is still fairly satisfactory with direct-current machinery. But it is, perhaps, the worst possible regulation that could be devised for alternating-current machinery. The Steinmetz potential regulator, described in the December, 1896, article above mentioned, will give a far wider range of impressed E. M. F. at the terminals and consumes practically no energy whatever. It is not surprising, in view of this fact and in view of the peculiar torque curve of the induction motor, that these experiments did not result successfully.

For railway work the multiphase motors, which are the only ones which we have discussed thus far, are open to another rather serious disadvantage, in that they require two trolley wires, even with a ground return. It, therefore, seems logical to turn to the single-phase system in railway work. The single-phase motors have, in addition to the difficulty of speed control, another very serious objection, in that they are not, generally speaking, self-starting under load. To describe, even in a general way, the various arrangements which have been devised to overcome this difficulty would be to unduly extend this article. It has been proposed to artificially dephase the current at the motor, by a self-induction coil, or a transformer, as proposed by Galileo Ferraris, as far back as 1888, or by a self-induction coil in one circuit and a condenser in another circuit, as proposed by Blathy in 1891. Tesla worked out a number of such schemes, all eminently suitable for driving fan motors or me-

ters like that of Shallenberger, but not well adapted for large powers. The Steinmetz and Berg monocyclic starting device, with two transformers with reversed windings, shown in their patent No. 558,119, April 14, 1896, is another solution of the problem. All of these devices, however, take very large starting currents. Among others who have attacked this problem are the French inventors, Hutin and Leblanc. Their self-starting single-phase motor consists of an ordinary primary winding, adapted to generate a single-phase alternating flux, and an ordinary short-circuited secondary, with a flux screen composed of a number of copper bars, arranged like a squirrel cage winding, mounted to rotate independently in the air gap. The action of this machine can be explained in several ways, but it is perhaps simplest to remember that a single-phase flux of a given maximum value may be considered as equivalent to two independent fluxes, each of one-half that value, rotating in opposite directions, with the speed of synchronism. If the squirrel cage be started in rotation by any suitable means, as by a small independent motor, it will run up to a speed closely approaching that of synchronism, since it has no load, and will there revolve like the armature of a single-phase induction motor, without consuming very much energy. It will then cut one of the imaginary rotary fluxes, that one which rotates in a direction opposite to its own direction at a high speed, and will operate to blow out the flux, and leave the other rotary flux, which rotates with its own speed and in its own direction, free to act upon the armature. Such a motor has been built in France, on a fairly large scale, and worked with good efficiency.

Various other arrangements have been devised, which are not yet ready to be made public, and, indeed, the art is a very active one at present.

In conclusion, it may be stated that the multiphase motor has ben developed and standardized for certain purposes only, namely, those purposes in which practically constant speed is useful and necessary. For starting heavy loads rapidly an alternating motor is not, by itself, well adapted, and can only be so adapted by extraneous devices which are as yet in a condition where, though promising great results in the future, they are not actually upon the market for commercial purposes. As the high-speed long-distance railroad becomes more prominent, as it must become as time passes, it is obvious that it is to the alternating motor that the engineer must resort, for a rotary converter sub-station every five or ten miles is a makeshift too complicated, expensive and inefficient to be really permanent, while a direct-current generating station every five or ten miles is still worse.

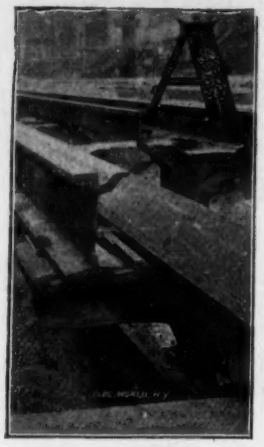
The Death of Dr. J. Victor Wietlisbach.

On November 26th last Dr. J. Victor Wietlisbach died in Berne, Switzerland. He was known throughout Europe as the official head of the Swiss telephone system, and as an author of great ability and originality, especially in connection with telephone subjects. Dr. Wietlisbach was born in 1854 in Bremgarten, Switzerland, his father being the head forester of that place. After a course of mathematical and physical study in the polytechnic school at Zurich he engaged in the study of electricity under Helmholtz, at Berlin, graduating in 1879 from the university there. Working for a while in the installation of electric light systems he later became manager of the newly organized Zurich Telephone Company, in which position he remained until 1884. In that year he was made chief engineer of the Swiss telegraph department and secretary of the technical division of the Government service, which positions he held until the time of his death.

He was one of the most prominent representatives of telephony in Europe. His researches on telephonic apparatus and methods were many and of great importance, and his publications on these subjects were very numerous. He was among the first to use the telephone instead of a galvanometer in connection with Wheatstone bridge measurement of resistance. The majority of his literary work was published in the French and German technical journals. In 1886 he published his widely known work, "Die Technik des Fernsprechwesens." Dr. Wietlisbach received equally as much recognition for his great practical activity as chief technical officer of the Swiss telegraph and telephone systems as for his more theoretical labors. The high standard of the Swiss telephone practice is largely due to his ability.

The Evolution of the Rail Bond.

BY HAROLD P. BROWN.



ABOUT twenty-five or thirty years ago, the rails of steam roads were first used for signal circuits. It was soon found that even with a battery current of less than one ampere, the coating of rust between the rails and the fish plates or chairs interposed great resistance and made necessary an additional conductor across the joint.

It is the purpose of this article to trace the development of these additional conductors, or bonds, as shown by the patents issued, and by the records of practical work.

The early track circuits were not bonded and the resulting troubles were ascribed to loose fish plates, as is shown by the first rail bond patent, No. 155,259, which was issued September 22, 1874, to William Robinson, and is entitled "Splices for Electric Track Circuits." It was a curved sheet of spring metal placed under the fish plate as shown in Fig. 1, and was intended to "insure good metallic connection between the rails, even when the splices are loose." Mr.

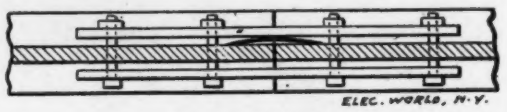


Fig. 1.—The First Rail Bond Patent, 1874.

Robinson modestly says, nowever, that "with good fished joints it may in some cases be dispensed with."

The inventors of the second bond patent, No. 227,102, dated May 4, 1880, had learned by experience facts that are overlooked by some electric railway engineers of to-day. They say: "It has been found in practice than the usual chairs, or fish plates, do not in dry weather afford sufficient good metallic continuity to form a good conductor, chiefly on account of the oxidation of the surfaces.

"To obviate this, elastic contact pieces have been used, intended to be caused to rub by the deflection of the rails, and thus always afford a contact surface of bright metal. It is known, however, that a conductor composed of many pieces in contact with one another, as a wire spliced, but not soldered, at many points, offers more resistance than one of continuous metal."

Their device, which is still used by a few roads, is composed of a wire whose ends are coiled around a tapering stud and dipped into molten solder. This, when driven into holes drilled in rail base, is said to "insure a perfect electric connection." In the same year, 1880, the Menlo Park electric railway was operated, and many of the methods then devised survive in modern practice.

From his experience as a telegrapher, Mr. Edison realized the absolute necessity of good electrical contact at the joints, and gave this matter most careful attention. The web of the rails around the

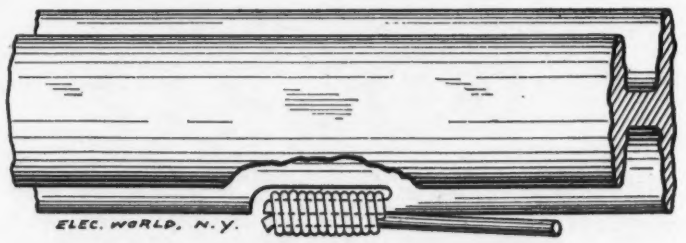


Fig. 2.—Field's Rail Bond, 1883.

bolt holes was filed smooth and bright. The rail ends were then immersed into an electro-plating tank and given a tough coat of nickel. Flattened copper wires were placed against the web of the rail above and below the track bolts, and clamped into place by the fish plates. This gave much better results and was more practical than the best of modern plain copper bonds. Both here and in the Edison road of 1889 and 1890, at Orange, N. J., some of the bonds used were of such character as to be well described as the "horseshoe bond" patents of 1895.

In Patent No. 275,180, dated April 3, 1883, Stephen D. Field is the first to mention the need of a rail bond for the "propulsion of railway trains by electric currents." His device required the cutting of a slot in the base of the rail so as to form a "finger" about 2 inches long, against which the bond wire is laid. A spiral of smaller wire is then wrapped around both, and secured by soldering or brazing, as shown in Fig. 2.

It is interesting to note that Mr. Field is the first to show a loop in bond wire to allow for expansion and contraction. He also fore-

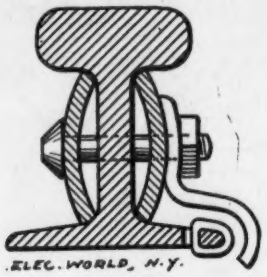


FIG. 3.—FIELD'S BOND WIRE PROTECTOR, 1883.

saw the theft of copper bonds, since he described a guard plate, which is held in place by the track bolts and bends over the wire so as to shield it. This is shown in Fig. 3.

On July 31, 1883, two patents which are even now well worth a careful reading, were issued to George Westinghouse, Jr., the pioneer in so many lines of invention. Concerning the use of solder Mr. Westinghouse says: "In manufacturing on a large scale it is practically impossible to remove all trace of the acid employed in soldering, and any which may remain is active in corroding the

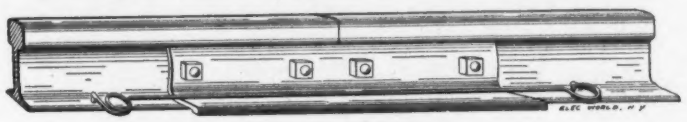


FIG. 4.—WESTINGHOUSE RAIL BOND OF 1883.

wire and thereby weakening it. The wires are subject in use to more or less vibrating movement * * * which in time imparts a crystalline structure to the metal of the wire. Also the vibrations of the wire and the movements of the rails acting upon the pins tend to loosen them in their holes."

This bond is composed of a single piece of wire, bent so as to have driving shoulders, and with one or more spiral coils to give elasticity, as shown in Fig. 4. It is still used in signal circuits.

But the day of spring contacts was not yet past, for in September, 1883, a Kentucky inventor patented a spring spur washer to fit track bolts, between rail and fish plate. In the following year others employed by the same signal company brought out some complicated

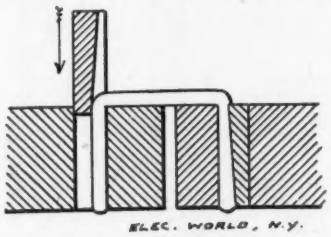


FIG. 5.—ORCUTT'S CHANNEL PIN, 1888.

spring devices, clamped beneath rail or screwed to ends of fish plates. The last of this class appeared in December, 1887, and comprised a copper plate under the fish plate, bearing against heads of copper pins riveted into the ends of the rails.

The same inventor, E. L. Orcutt, designed in 1888 the first form of channel pin, shown in Fig. 5. In the same year, inventors from Kentucky brought out the first bond of the type now known as the "Columbia." This comprised a straight or tapered hole in the rail, a wire bond and a conical collar having a hole to receive the end of the bond.

Charles J. Van Depoele on May 7, 1889, made a departure from the beaten paths, as shown in Fig. 6, and was the first to suggest the use of supplementary rail return wires which were quite necessary with the light tram rails for horse car service. This device shows a flattened U of sheet zinc placed between the base of the rail and the supporting stringer. The loop of the U projects beyond the edge of the rail, and in it is soldered the supplementary wire. Mr. Van Depoele laid great stress on the "non-oxidizable" character of sheet zinc, and evidently planned to use a steel return wire. But he perhaps overloooked the fact that zinc comes next to lead in rapidity of corrosion from electrolysis.

The use of a thin sheet of zinc between the base of the rail and a copper bond has recently been again suggested, but the galvanic action between these two metals will quickly destroy the contact.

In 1890 Mr. Van Depoele patented the use of a sheet of zinc under the fish plates. In this patent he says that he is "aware that

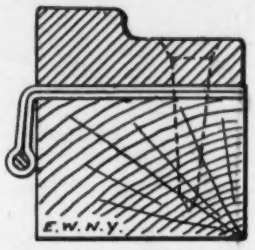


FIG. 6.—VAN DEPOELE'S BOND, 1889.

it is not broadly new to connect the extremities of railway rails for the purpose of using them as a circuit."

On the Field-Edison electric road in the Railway Exposition at Chicago, in June, 1883, the rails were bonded by wires placed under the fish plates or beneath the rail base.

The constructors of the early electric railways followed in the path of the signal men. At first it was gravely said that "the earth was a reservoir of electricity," and the rails themselves furnished sufficient "ground connection." Some of the experts of those days "calculated" the size of trolley feeders as though they were the completed circuit, and said that only a few ground plates were needed, since "the earth was a conductor of practically no resistance."

The Richmond road in 1887, had its principal return through ground plates. Then it was reluctantly admitted that a piece of No. 4 galvanized iron wire, roughly riveted into a hole in each rail, was perhaps needed to secure a "perfect return." Later, copper wires of shoe-string sizes were used, and only a few months ago some "tables" were published as valuable information for engineers, giving the calculated resistances of a mile of steel rails of various sizes, to which was added, as an aid toward computing size of the trolley conductors, the resistance of so many feet of iron and of copper bond wire per mile, as though the sum of the two would give the accurate track resistance. In these tables the resistances given for 70 pound and 90 pound rails are not proportional as 90 to 70, and the figure given for the 70-pound rail is lower than it should be for a 100-pound rail.

It is much easier to sit down and calculate from "data" what the track resistance ought to be than to find by testing what is actually measures, but it would be safer to first verify the data. Unfortunately the contact resistance of a single bond may often be higher than the calculated resistance of a mile of continuous rail.

Early in the nineties other experts, following Mr. Van Depoele's practice with light rails, decided that a heavy rail having the carrying capacity of a square inch of copper, required a "supplementary wire" of No. 0 or No. 00 copper, which was soldered to the bond wires. Careful observers were afterwards surprised at the rapid disappearance of the solder, and frequently of the supplementary wire itself, but at that time electrolysis was not suspected of the theft.

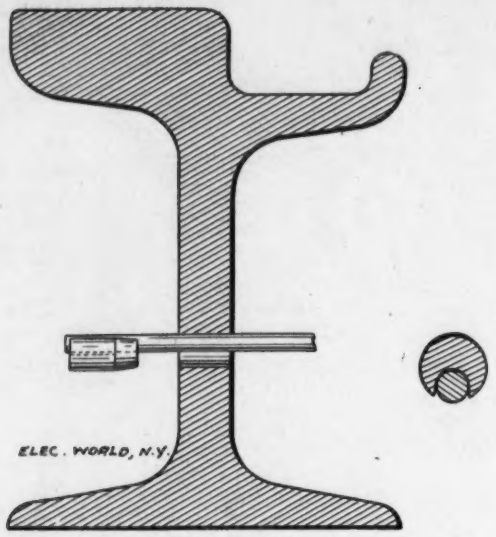
In April, 1890, Mr. Charles A. Lieb introduced a bond composed of a pair of tapering pins with large heads, through which holes were bored for the bond wires. The patent shows a rigid rod of wire, with no provision for expansion, but in service a kink or spiral was made in the wire.

Mr. Orcutt patented in August of the same year, an improvement on his channel pin, which is a tapering tube, split at one or more points in its periphery. The bond wire was put through a hole in the rail, the split tube slipped over it, and both were then driven home, the taper forcing the tube to clamp the wire and press it against the surface of the hole.

William H. Garland follows in December with an improvement on Orcutt's channel pin, as shown in Figs. 7 and 8. This was the most successful of the channel pins with the contractors. A groove to fit the wire of the bond was cut on its periphery, and the pin was given a slight taper. When the pin was driven the wire had a slight line of contact with the rail itself. Mr. Garland drew his own patent and though the rail-section shown is something "never seen

on sea or land," the breadth and subtlety of the claims are beyond criticism. I cannot resist quoting one claim.

"The combination, with a railway rail or other large electric conductor provided with a hole or perforation therein, of a wire or other small electric conductor to be attached thereto, and a connector to be driven into said hole with said small condutor to connect both said conductors, consisting of a cylindrical pin or plug tapered at its end and having a straight longitudinal groove on its



Figs. 7 and 8.—Garland's Channel Pin, 1890.

side of sufficient width to allow the conductor to be placed upon the small conductor and said conductor to enter said groove, the bottom of said groove being parallel with the outside surface of the cylindrical portion of said pin, the largest diameter of the pin being a little larger than the hole in the rail or other conductor, for the purpose set forth and described."

In his next patent he employed attorneys who knew how to draw both rail sections and claims. They covered for him a channel pin, whose only difference from earlier forms was that the hole for the bond wire was not in the centre. But these same attorneys had previously drawn for G. K. Wheeler a channel pin patent exactly similar to Orcutt's, whose patent issued just three months before Wheeler's application was filed.

In June, 1891, a patent was issued which seems to cover the form that several years later was called the "Chicago Bond," and which made a fortune for its inventor. It is to be hoped that the earlier man was equally fortunate. His device is shown in Fig. 9, and it is described as follows: "My invention comprehends the employment of terminals having holes through them, and bolts, or equivalents, by which they may be connected to the adjacent end of the rails, and a

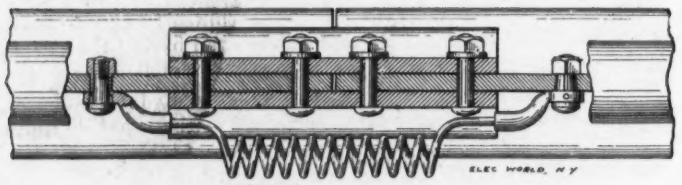


Fig. 9.—Bickford's Bond, 1891.

wire, or wires, connected to the adjacent ends of the rails, and a wire or wires connecting said terminals. The terminals preferably have in addition to the bolt-receiving holes, a concentric slitted projection, which is expanded by the tapering shanks of the bolts." These terminals are placed into holes in rails, and the tapering bolts are driven home with sledges, the nut merely serving as a lock. The claims are well drawn and very broad.

Skipping the bond patents of 1892 and 1893, as they merely ring changes on Mr. Westinghouse's work, we come to the "Chicago Bond" patent, issued January 16, 1894, after nearly a year's delay in the Patent Office. This well-known device is shown in Fig. 10, and is described as follows: "The bond wire *B* has tubular or thimble-shaped connectors, *C*, *C*, forged or welded on its ends. These connectors are inserted into close-fitting holes, made for the purpose in the ends of the rails. And the drift pins, *D*, *D*, which are made larger than the openings in the tubular connectors, *C*, *C*, are driven into said connectors, to expand them and wedge them securely in the holes in the rails."

Fifteen bond patents were issued in 1894. Two of these are merely clamps for the supplementary wire, and are rivetted or screwed into the rail. Two others depend for contact upon screw-threads cut into ends of the copper bonds. Mr. A. L. Johnston's device is shown in Fig. 11, and Nichol and Lincoln's bond in Fig. 12. The latter has a cup-shaped nut, into which is poured molten lead, tin, solder or antimony, to secure the contact from oxidizing.

The designer of the "cast-weld" rail joint figures as a co-inventor

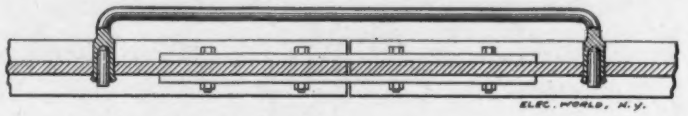


Fig. 10.—Keithley's Rail Bond, 1894.

of a solid rod rivetted to rail, with a washer slotted to fit a rectangular bend in the rod. Dozens of other bonds have been patented during the past three years which are modifications of previous types of rivet, clamp, wedge, or screw. There has been a great de-

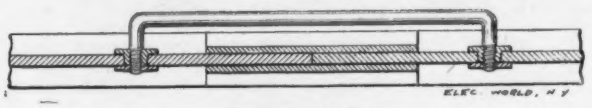


Fig. 11.—Johnston's Bond, 1894.

mand for a cheap, short bond, formed of flexible bands or strips of wrought copper, with cast copper heads. These are very high in resistance, but they last long enough to permit the contractor to get his money, since few roads have any testing instruments to detect poor bonds.

Electrically welded rails, "cast-weld" joints, and copper bonds, welded or soldered to the rails, have been heralded as solving the

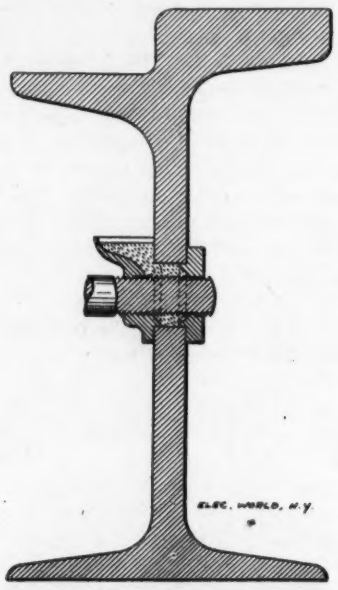


Fig. 12.—Nichol and Lincoln's Bond, 1894.

bonding problem, but electro-metallurgy is full of surprises and these solutions have failed in unexpected ways.

Electric welding has produced a joint of comparatively high resistance, through the presence of the necessary flux between the surfaces. It has also decarbonized the steel so that two low spots have been worn on tread of rail at each joint; while the expansion of the rail in hot weather has badly twisted and distorted the track.

The fact that "cast-welded" track does *not* buckle in hot weather proves that it is not a weld, and in the presence of a slight clearance at each joint lies the secret of its mechanical success. This clearance is evidently caused by the expansion of the rail, when surrounded with molten metal. Of course, this metal hardens before the rail resumes its former size, thus leaving a crack for admission of moisture to oxidize the contact surfaces.

(To be continued.)

The Management of Central Station Meter Systems.

BY CARYL D. HASKINS.

MUCH has been written regarding the selection of a desirable meter. Central station managements, which a comparatively brief time ago based their selection of a meter first upon the initial cost and second upon the accuracy of the meter under average loads, have come to a realization of the importance of looking for many other merits and demerits. If they are operating an alternating current plant they realize that they must secure accuracy upon inductive loads, upon different wave shapes and upon different frequencies; and whether the system be direct or alternating in character they realize that light load accuracy is of the most vital importance.

The details of care and management of the meter system necessary to secure the best results have received careful attention of a systematic kind in isolated cases only, for it would seem to be a common belief that the mere fact of purchase of satisfactory meter is regarded as sufficient to insure good operation over long periods.

As a matter of fact, the influence of proper meter care and intelligent management have a most important influence upon revenue, and this care should begin with a wise selection of the meter which is to be installed upon each individual customer's circuit, particularly as regards the size of the meter to be used. A very large proportion of a central station's total output goes to supply loads of one or two lamps, and unless diligent care is used quite a large percentage of such loads fails to be properly recorded upon the meter, and the central station's revenue suffers accordingly.

This consideration is of special importance in connection with domestic lighting, which is not infrequently regarded as unprofitable. That lighting of this character can be made profitable in almost every case by careful attention to the question of metering is certain.

Generally speaking, needlessly large meters are installed on the average system. In all meters the light loads are the critical points of accuracy curve, and for this reason meters should always be installed in as small units as possible.

It is better to err on the side of too small meters than upon the side of too large meters. It is better to lose an occasional meter from a burnout resulting from extreme overload, than to lose a considerable percentage of the revenue which should be secured from long sustained light loads.

This is a point which should not be lost sight of in the selection of a meter. Not only is ability to sustain heavy overloads for considerable periods of very great importance, but accuracy on overloads is quite vital.

All forms of meter have a range of speed through which they perform their functions to the best advantage, both accuracy and life being considerations in determining this speed. If the load upon the meter fall so low as to bring the speed of the meter below the minimum of this speed range, then accuracy suffers. On overloads the speed of the meter is carried up above the maximum of the normal range, and with a properly selected meter accuracy should not be impaired. The life of the meter may suffer, and of course upon extremely heavy overloads the insulation and structure of the meter will suffer by reason of the mere development of heat. Overloads may, therefore, if carried to extremes, mean meter repairs; that is, a small expenditure. Extremely light loads mean direct loss of revenue, and practice teaches us that these light loads should be avoided, even though such avoidance means an occasional overhauling. The increase of just revenue due to a systematic following of this practice will be found to cancel many times over the relatively small expenditure incident to damage resulting from overload, even though occasionally, as now and then occurs in domestic lighting, some one gives an upexpected party, resulting in a burnt-out meter and the necessary installation of a new instrument.

In large buildings the conditions are frequently such as to render it peculiarly difficult to meter to good advantage. An excellent example of this class is to be found in the average theatre or church installation, where a very large number of lamps are used for long periods very frequently. Yet in this very class of installation relatively very small loads are constantly used for many hours at a time. It is almost impossible to install a meter large enough to care even on a heavy overload basis for the entire installation which is so frequently used, and yet secure any reasonable accuracy on the long sustained light loads.

These are very radical cases, and it will be found vastly more profitable to meet them with radical measures than to install a large meter and lose a considerable percentage of the revenue due to the central station company for light load service.

In all cases of this kind it is cheaper in the end to split the service and run two, three or four separate circuits, each with its individual meter. In a theatre, for example, one, two, three or four lights, indeed as high as twenty lights in some cases, burn for the greater part of the time in the offices, entrance and main corridor, while during the performance the lights run up to six or eight hundred. First-class accuracy should not be expected from a meter fit to withstand commercial use for any length of time on loads of less than 5 per cent. of its rating. In a case of such a 500 or 600-light theatre, therefore, a single meter would lose to the central station a very large percentage of the revenue properly due for light furnished in the offices and in the entrance.

The remedy is to place the offices and corridors upon a separate circuit having a separate meter, and in very large theatres it is frequently profitable to make the offices, the corridor and entrance, the house and the stage all independent.

This same line of practice should be followed, not alone with theatres, but with all of that large class of installations using both very heavy and very light loads for long sustained periods.

It is commonly understood that light load accuracy is a critical point with all meters, but it is not so commonly understood that this light load accuracy, or rather inaccuracy, is largely dependent, first, upon the installation and, second, upon the care which is accorded to the device.

Recording meters run slow on light loads, because at such loads the torque is relatively low and the friction load relatively high. If, after the calibration of the meter, this friction load is modified, then the light load accuracy of the meter is immediately affected, and as, for obvious reasons, the friction load may be said to never decrease, the meters tend, if they change at all, to run slow, not fast on light loads.

It is obviously, therefore, to the advantage of the central station company to use every precaution to prevent the increase of the friction load, yet in due care in this particular central station managements very commonly fail.

These increases of friction may result from numerous causes. There are, however, three chief factors in the matter, which, when properly guarded against, will prevent any considerable trouble from slow meters. These are as follows.

First—The point of installation.

Second—The manner of installation and proper adjustment at the point of installation.

Third—The accumulation of dirt.

All three of these factors need careful attention, and by such attention the revenue-impairing influences may be quite fully guarded against.

In the selection of the point of installation special care should be exercised to avoid vibration. The average meter is to-day installed in whatever location the wireman may have thought it best to leave the necessary loops, and in both domestic and other classes of service the point which is most convenient for the wireman is rarely the best place for the meter. The damage to light load meter accuracy by reason of vibration is much greater than is generally understood.

Wearing of the jewel results almost entirely in its initial stages from reciprocating and not rotary motion of the shaft. A very inconsiderable amount of vibration, especially if it be of the rhythmic kind, *i. e.*, such as results from moving machinery, will speedily set the shaft into motion vertically. By this action the carefully rounded shaft point is gradually hammered out of shape, and sooner or later the jewel becomes slightly chipped. As soon as the jewel becomes chipped, a kind of grinding action begins, and the rotary motion from this point onward carries forward the evil work which in its early stages was due purely to vibration.

These jewel troubles are, one might say, of a microscopic nature, but no magnifying glass is needed to detect the result upon the revenue, as many a central station knows.

Since vibration is not always avoidable, care should be exercised

to see that meters are so constructed as to permit the ready renewal of both shaft point and jewel without the necessity of removing the meter from the point of installation.

The bad effect of vibration is not confined to the jewel and shaft point. It tends to gradually shake loose fine wire connections, and even occasionally to break off fine wire; and in meters having commutators it tends to cause sparking at the brushes, thereby building up an uneven surface on the commutator and increasing the friction factor.

The proper care and cleaning of meter commutators is dealt with quite fully a little further on in this paper, but a careful selection of point of installation should be regarded as the "ounce of prevention" which will make the "pound of cure" troy weight rather than avoirdupois.

First and above all things, it is important to find the point of least vibration, and if possible to put the meter at that point. The old steam engineer's trick of holding a pencil or rod between the teeth and pressing it firmly against the wall or point of support, is a good and ready means of determining the character of vibration.

In the average installation the point of least vibration will be found in or near the ground floor, not under the roof. In the average dwelling every heavy team that passes affects the meter more if it be in the garret than in the cellar.

In the metering of office buildings one should try and put the meter against a brick wall, and, above all, wooden partitions with banging doors should be avoided.

Again, in selecting the point of installation extremes of heat and cold, and points exposed to dust, dampness or chemical fumes, should be shunned. In domestic work many of the meters which are installed in garrets, especially when under tin roofs, are exposed to surprisingly high temperatures in the summer and low temperatures in the winter. Cellars, unless peculiarly damp, are almost always better than garrets. Kitchens, pantries and the like are also bad places for meters, for there is no hiding place so dear to the elementary hearts of the various insects which haunt the abodes of man as the inside of a meter, and even though a meter be apparently bug proof, insects will find their way in and wax great and happy, thriving, perhaps, on their kindred of later coming.

Having selected the best point to place the meter, no small care should be used in putting it up. The location is seldom ideal, but much can as a rule be done to improve conditions by care in installing.

It is quite important that meters should be level, for they are calibrated in a level position, and friction is generally increased if they are not so installed. Where vibration cannot be avoided, meters can frequently be cushioned. Some few central station managements provide racks which carry the meter upon sponge rubber cushions, and these racks are used at all points where vibration is considerable. There is no doubt that this arrangement is wise wherever vibration cannot be avoided.

In installing meters in connection with motor service, the meter should be placed on the station side, not upon the motor side of the controlling switch. This is important, not only on direct current motors, but also in connection with all polyphase work. The reason why meters should be so placed is twofold:

All forms of recording watt-meters have potential windings of fine wire, the mechanical strength of which is, of course, low. Every time that the controlling switch is used this fine winding is cooled or heated, and the resulting expansion and contraction causes the insulation of the fine wire to chafe and weaken, and occasionally actually breaks off the wire.

Again, when the main switch is pulled there is commonly a high potential back kick, which searches out any point of weak insulation, caused as a rule by the chafing just mentioned, breaking through and causing a burnout and rupture of the potential winding. The meter comes to a standstill, and repairs are necessary, Much, if not all, of this trouble could be avoided by placing the meter upon the service side of the switch.

Having installed the meter in a satisfactory location and in a careful manner, it should not be assumed that it will go on for an indefinite period giving results of the highest accuracy without future care. Meters, like clocks and watches, need periodic care and attention, and the expenditure of a small amount of money for cleaning and inspecting will be found to have a gratifying effect upon the revenue, and will make the necessity of serious repairs a most unusual thing.

There are many mistaken ideas as to the time and care which it is necessary to give for the proper cleaning and periodic inspection of meters. The average meter should be visited for the purpose of cleaning and inspection from two to three times annually. On each visit of this kind the cover should be taken off, any dirt or dust which may have accumulated should be removed, not with a brush, but with a pair of bellows. The condition of the jewel should be tested by taking the shaft gently between the thumb and finger and moving it slowly and gently over the surface of the jewel cup. If the meter be one of those having permanent damping magnets, the inside of the poles of these magnets should be brushed off with a thin piece of magnetized steel cut into convenient shape. If the meter have a commutator it should be gently cleaned with a piece of narrow cotton tape, and the meter is ready to be closed up and will go on doing efficient work.

In testing the jewel as just described it will be noted that a perfect jewel feels smooth and glass-like, while a damaged one feels rough and gritty.

The cleaning of a meter in the way just described takes on the average only about five minutes; never more than ten—not a large expenditure to insure continued good operation.

It is not infrequently said that when visits are made as frequently as every four months there is seldom anything to correct, or any part which needs cleaning. This is generally true so far as the evidence of the eye goes.

Meter troubles, however, begin on a very small scale. One might almost say upon a microscopic scale, but the trouble, having once found a footing, increases in magnitude with great rapidity, and it is to remove the causes of trouble in their initial stages, when they are easy to reach, that frequent cleaning and inspection is recommended.

There is, oddly enough, one particular little "Don't" on these periodic visits to meters which is done all too often. The meters should not be oiled. The merest film of oil upon the jewel lasts for an indefinite period. More than a fiim is detrimental, as is oil at any other portion of the mechanism. The light-load accuracy of hundreds of meters has been ruined by what was regarded as a conscientious use of oil. Better no oil at all than too much.

As to the testing of meters, it is the common impression that meters should be removed from the point of installation and taken to the station or the laboratory in order to be given a proper test. In reality this should be necessary only in rare cases, and this particular fact should be borne in mind when installing, and meters should always be placed in situations where they are reasonably accessible and not absolutely in the dark.

Meters are tested on the average system for one of two reasons—either because of a complaint on the part of the customer, who claims that his meter is too fast, or from a suspicion on the part of the central station management that the meter is under-recording. Customers' complaints are very common in the winter, when the bills are normally high, and it will generally be found that about 95 per cent. of the complaints originating with customers are without foundation.

Tests necessitated by suspicion of slow operation are, generally speaking, more important, because they are more commonly founded upon actual existing conditions. There are half a dozen methods for testing meters at the point of installation, and all of them are more or less satisfactory. One or more of these methods should be used on every occasion before resorting to the removal of the meter, which should be regarded only as a last resort in case the meter proved to have defects which cannot be remedied *in situ*.

In testing meters in response to a customer's complaint, where the central station management does not share in a customer's distrust of the meter's accuracy, it is frequently only necessary to make a rough lamp test; but this form of test should be used only if the central station management has every reason to believe the meter is accurate.

The lamp method of test merely necessitates putting a definite number of lamps upon the meter, multiplying this number of lamps by the watts per lamp if the meter under test be a wattmeter; or by the current per lamp in amperes if the meter under test be an ampere meter, thus determining approximately the total load in watts or amperes under which the meter is operating. By using the proper formula (and there is a simple formula of this kind for every commercial form of recording meter), the speed at which the meter should revolve at this particular load can be immediately determined. The actual speed of the meter for one, ten or 100 revolutions should then be taken with a stop-watch, and any discrepancy

which there may be between the theoretic and the actual time per revolution at once shows what percentage of error there may be in the record of the meter. This method is, of course, only an approximate one. It may be regarded under average conditions as being within, say, 6 per cent., the source of error arising in the probability of variation of actual from theoretic watts or amperes per lamp.

The above method of test can quite frequently be reversed with quite dramatic effect, when testing for peculiarly suspicious customers, by instructing the customer to turn on a number of lamps known to him, but unknown to the tester, who can then time the meter and tell the customer, with little probability of error, how many lamps are burning.

The lamp method of test should not be used where the central station management has any reason whatever for doubting the accuracy of the meter; nor should it be used in connection with the settlement of disputes of any great magnitude or importance. It is not sufficiently absolute.

Some positive means should be used for determining the actual energy or current passing through the meter. If there be no inductive loads this can be done very readily with an amperemeter in series with the recording meter on the load side and a voltmeter across the line on the station side of the recording meter. Or, if the recording meter be an ampere hour the ammeter alone will be needed.

It is yet better and easier to use an indicating wattmeter of one of the several accurate and reliable types now procurable, which, on being connected in series with the meter under test, read directly in watts the load which the meter is carrying.

A third and generally very satisfactory method of testing suspected meters consists in using a light, portable, perforated box, having, say, six calibrated incandescent lamps on the inside, varying from 16 to 50 candle-power, and all connected to two binding posts on the outside of the box, each lamp being controlled independently by a snap switch also on the outside of the box. The lamps used should be selected of a voltage of from four to six volts higher than the normal maximum potential of the service upon which they are to be used, and they should then be carefully measured individually and the energy used in each lamp established and marked upon a calibration card by one-volt steps, beginning at the minimum and running up to the maximum likely to be met with upon the system.

By connecting this set of portable lamps as the sole load upon the meter and measuring the potential with a small portable voltmeter, it is only necessary to refer to the calibration card of the lamps to determine just what load the meter is operating upon. This system has the advantage of providing an extremely flexible testing load, and as the test lamps are used only for brief periods and on potentials below those for which they are constructed they will retain their calibration for a long time, although they should of course be remeasured with reasonable frequency.

By testing meters at the point of installation much time and expense can be saved, and cases where the removal of the meter is necessary will be found to be very rare, especially if a proper system of care and cleaning is enforced; for such errors as are discovered will almost always be directly traceable to trivial mechanical faults and can be remedied promptly without taking the meter down at all.

The inaccurate reading of meters has in the past been a prolific source of error and dispute, and in less but still serious degree this is yet true. Meter reading should be the work of cheap men, but cheap men can seldom be relied upon to practice due care in the reading, if they be intrusted literally with the duty of translating the showing upon the dial.

The reading of a meter dial, whether it be a gas, water or electric dial, is always somewhat puzzling, and in some positions difficult even to the initiated. The actual translation of the dial indication should not be intrusted to the men who visit the meters to take their state. These men should go no further than to mark with a pencil the position of each hand upon a printed diagram of the dial. This the most unintelligent can do with sufficient accuracy, and the average man can read, or rather take, the state of 75 per cent. more meters a day in this way than if he attempt to actually translate into figures.

The diagrams of a day's reading should all be read at the office by a competent person skilled in the rapid translation of meter dial records. By this means almost every liability of error is removed, and in addition the central station management has the best of evidence as to the actual state of the meter for use in case of subsequent disputes.

Probably the most useful and satisfactory system of meter dial records is that which provides cards for each meter customer, good for a six months' record, bearing at the top space for the insertion of the customer's name, the meter number, the constant, and such other information as the central station management may find helpful in quick reference, as, for example, the capacity of the meter, number of lamps connected, the potential, and always a space for remarks.

Beneath these headings should be six diagrammatic reproductions of the meter dial ready for marking, and beneath each separate diagram should be provided a place for inserting "Indication," "Last Reading," "Consumption," and, with ample space, "Remarks."

The meter reader takes his route by the cards which are handed to him in the morning, and his duty consists solely in marking the position of the hand on the diagram for the month, entering the date of reading under or opposite that diagram. The remainder of the work is done at the office, and the cards, always up to date, furnish an immediate means of reference when systematically arranged, as they should be, in a filing drawer.

Most central station managements have found that the bulk of all the complaints which they receive come in during the winter months, when the bills are of course heaviest. Some central stations have found it very helpful, therefore, to make their winter months shorter and their summer months longer arbitrarily. Thus, the October reading may be taken November 5, the November reading December 2, the December reading January 1, the January reading January 30, and the February reading February 27. A system of this kind tends slightly to even up the months, making the summer and winter bills not quite so disportionate as they might otherwise be, and yet works no injustice to the customer.

In the management of a meter system relative success or failure rests in attention to little things, and an illuminating company changing from a system of little or no care to a system carefully arranged to provide for proper attention to all of the small details will find that the resulting change in revenue will be most marked; sometimes indeed it will be found to be so great as to be an important factor in the ability of the company to pay satisfactory dividends.

A Relic from the Patent Office.

Another instance of the delays that may be effected in the prosecution of a patent case in the United States Office, and of the worthlessness of such a patent when issued until adjudicated by the courts, is instanced in the set of patents issued December 21, 1897, to the assignees of Rudolph M. Hunter. One of these has a record date of 1883, and the other two of 1887. The first of these patents covers generically the whole field of alternating current working, using transformers for stepping down the voltage. The seventh claim, for example, reads as follows:

"A method of transmitting electrical energy consisting in transmitting an electric current of high tension and small volume over a line circuit and at one or more places on the line circuit, producing by means of induction currents of low tension and relatively large volume, and supplying said low tension currents to one or more translating devices in said local circuits."

The other patents make various detailed claims of step-up and step-down arrangements, the multiple use of transformers, etc., but all contributory to the patent from which the claim above is quoted.

If such patents as these can be sustained by the courts, and allowed a life of seventeen years from December 21, 1897, it is certainly time that some radical change is made in the American patent system.

The Successor to Mr. George R. Blodgett.

The vacancy created by the death of Mr. George R. Blodgett has been filled by the appointment of Mr. Albert Gould Davis to the position of acting manager of the patent department of the General Electric Company at Schenectady. Mr. Davis, although an exceptionally young man for a position of such responsibility, has been fitted for his work by a technical education received at the Massachusetts Institute of Technology and several years' experience in patent work, both as assistant examiner in the Patent Office and as practicing attorney and solicitor.

Digest of Current Electrical Literature American and Foreign.

by Carl Hering.

The Digest has heretofore been printed in a style of type that it was necessary to set by hand. With the large editions of THE ELECTRICAL WORLD the type soon became battered, which marred its appearance. Beginning with this issue the Digest will, like the rest of the paper, be set by the linotype machine. This will give new type in each issue. In making the change we have returned to the larger sized type originally used for the Digest, but the lines are printed closer together. The matter may, therefore, at first sight appear a little crowded until one becomes accustomed to it. Readers, however,, as a rule are only interested in certain departments of the Digest, and do not read it continuously column after column, as they do the regular articles, and the closeness of the lines enables us to furnish them in the same space with considerably more matter than if the type were "leaded."

DYNAMOS, MOTORS AND TRANSFORMERS.

Alternator Equalizer.—Lond. *Elec. Eng.*, Dec. 10.—Several answers to the question of what the object is of this equalizer as used on the Mordey alternators; the armatures of these alternators are sometimes connected, so that half of the coils are in series with each other, and these two groups in parallel; the two currents leave the machine separately, and pass through the equalizer, which is somewhat like a transformer with two equal coils, through which the current pass in opposite directions, after which they join. Locke and others state that the object of the equalizer is to prevent the circulation of local currents in the armatures, as the voltage in one of the two circuits may be slightly greater than in the other.

Self-Exciting Alternator.—Elek. Tech., Oct. 31.—A note referring to a recent invention of Boucherot. The dynamo has two similar armatures, one of which is stationary and the other revolves; through both alternating currents flow, which differ in phase so that in every armature there is produced a revolving field in "one of the windings of each armature" a current differing in phase by a quarter of a period is produced by inserting condensers; in this way the two armatures are said to be capable of generating current without a separate exciter. (No further information is given, and the exact meaning is not quite clear. Ordinarily an alternator excited by an alternating current will generate an alternating current of double the frequency.)

Fuses in Field Circuits.—Lond. *Elec. Eng.*, Dec. 10.—Answers to a question whether it is necessary and advisable to put fuses in the field circuits of large generators. Fennell discusses the question at some length, concluding that the main fuse is as good a protection for the field as for the armature. Several other writers say it is neither necessary nor advisable to use field fuses.

Compound Dynamos and their Action. JENNINGS. *Amer. Elec.*, Dec.—The influence of the characteristics of dynamos on their action when running in parallel is discussed. The equalizer, it is shown, cannot compensate for variations in regulation due to differences in the characteristics. If simple shunt machines have dissimilar characteristics, when run in parallel, the machine with the steepest characteristic will not ake its share of the load when it in creases, and will not take more than its share with a decrease of load. The resistances of the series field coils of compound machines in parallel should be inversely proportional to the current capacities of the several machines, but to so adjust them with shunt resistances will do no good, as the shunts merely diminish the total flow of current, and in no way serve to adjust the effect of the coils relating to each other. (A considerable proportion of the article appears to be taken, without due credit, from a paper by Prof. W. L. Puffer, published several years ago in the *Technology Quarterly.*)

Care of Electrical Machinery. BAXTER. *Power*, Dec.—A continuation of his elementary series of articles showing the principles underlying the generation of current. As this is an elementary series which will apparently be continued for some time it will not be referred to again.

LIGHTS AND LIGHTING.

Electric Arc.—Elek. Anz., Dec. 2.—After a brief mention of a number of experiments by others, a rather long abstract of the researches of Herzfeld is given, the original being in the *Wied. Ann.*, No. 11. He endeavored to measure the counter E. M. F. immediately after the interruption of the current, and obtained about two volts or less. He experimented with the arc in an electric field, and found that the latter produced no effect on it. In order to find whether the temperature of the ends of the carbons had any effect on the voltage he used liquid carbonic acid gas, a thin stream of which was directed against one of the points of the electrode, or against the arc itself, the voltage being measured continuously. The results were that the difference of potential at the carbons increased about 5 to 10 per cent. when one of the electrodes was cooled in this way. The increase was greater when the anode was the upper one. When the carbons were horizontal the increase of voltage was greater. The cooler gases increased the resistance of the arc. The chief result of this test is that the voltage at the ends of the carbons increases by cooling, while the current diminishes. This increase cannot be explained by thermo-electric action. It is not impossible, however, that not only the temperature but also the chemical combination of the carbonic acid gas may have produced the result. Other experiments were made by confining the arc in a glass tube. It is claimed that these researches of Herzfeld give very good information regarding the true nature of the electric arc; also, that the results are of importance in practice.

Tests of Incandescent Gas Mantles. MEDLEY. Lond. *Elec. Rev.*, Dec. 10.—An article giving the results of some life tests. He shows that the mantles gave a very good light when new, but the great rapidity with which the light falls off, and the consequent shortness of their life, makes them far from being the ideal illuminant. Much improvement is necessary before they can be considered satisfactory. These tests will enable electric engineers to refute some of the extraordinary claims advanced on behalf of this system.

POWER.

Electric Elevators and Cranes.—Lond. *Elec.*, Dec. 10.—The beginning of a reprint of a long discussion of the paper which was noticed in the *Digest*, Dec. 18. Adamson stated that his company had generally used a shunt wound motor with additional series coils, as mentioned by the author of the paper, but it was found that with high speeds a varying load gave a variation in the speed, so that when it was stopped it would not respond at once, thus missing the landing; he overcame this by arranging an automatic switch to cut out the series coils after cutting out the resistance. Concerning travelling cranes he preferred the three-motor type using series motors, owing to the greater starting power and the characteristic of running faster under lighter loads, enabling the change of gear to accomplish this to be dispensed with; he found that some makers formerly using single-motor cranes were now using three-motor, while he had heard of none who changed in the other direction; the principal reason is to reduce the wear and tear on the mechanical portion, and the operator is able to start very gradually Ellington claimed that electric energy was subject to the same defects as steam, gas, and compressed air, all of which were avoided by the use of hydraulic power; he admitted that the power required in a hydraulic elevator was the same whether the load was light or heavy; for short lifts the hydraulic elevator will continue to be used; he discusses the question of the relative economies under certain conditions, showing a difference of 50 per cent. in favor of the hydraulic elevator; with full load the latter takes less energy than the electric elevator with the lightest load. Courtney said that for a short stroke the hydraulic elevator is better, but for a long stroke the electric one has advantages; he questions whether the attention required by the hydraulic elevator was materially less than for the electric one; he recommends sacrificing the small difference of efficiency between a good thrust bearing and a ball bearing, in order to get simplicity. Hollick, whose gear was referred to by the author, said that it gave much higher results than those of the crane described in that paper; he believes the losses took place between the motor and the load; he did not believe electric cranes were inferior to the hydraulic; he thinks the simplicity of the electric system would compare favorably with the hydraulic if the latter included an arrangement to increase the efficiency at smaller loads. Walker thought the simplicity of the hydraulic machinery was much greater; a comparison was not fair unless on parallel lines; a great advantage lies in the feature of storing hydraulic power. P. I. Unwin referred to the working cost of elevators, showing that the advantage of the electric one was that the power used is proportional to the load; the cost in an actual case was found to be greatly in favor of the electric elevator; when the Otis Company had to guarantee the lowest cost of maintenance they recommended the electric instead of the hydraulic elevator; the electric one is equally simple; the electric elevators for high buildings were, as a rule, 10 to 15 per cent. more expensive in the first cost, but when this is capitalized it is saved over and over again in the difference of the working cost.

Utilizing the Power of the Arc.—L'Ind. Elec., Dec. 10.—A note calling attention to the large power installations on this river, which rises in the French Alps. At La Praz there is a large factory for manufacturing aluminum and calcium carbide, the total power being 3000 horse-power, which will soon be increased to 13,000; one of the dynamos, which will soon be described in detail in that journal, is said to be the largest continuous current unipolar machine which has ever been constructed, and has the highest voltage; it has an output of 15,000 amperes at 40 volts. Some distance from this there is an electro-chemical factory where chloride of potash and soda, and calcium carbide are manufactured, the total power being 4000 horse-power. In another aluminum factory 3000 horse-power is consumed, and this is to be increased to 12,000. These three electrical installations therefore aggregate about 10,000 horse-power, which will soon be increased to 32,000.

Electrical Power for Machine Tools. BIGGE. Lond. *Elec. Rev.*, Dec. 10.—A reprint of the complete paper, of which an abstract was referred to in the *Digest*, Dec. 11; this reprint contains the table showing the power consumed by shipyard and other machine tools running light and loaded; in many cases a great part of the power used is expended in starting and running the machines, irrespective of what work they may be doing.

Water Power for Electrical Machinery. FIELD. Lond. *Elec. Eng.*, Oct. 22, 29 and Nov. 19.—A continuation of his long serial; in the latter installment he gives illustrated descriptions of some plants.

Electric Pumps for Boilers. SIMON. *Sc. Am. Sup.*, Dec. 18.—A translation of the short article noticed in the *Digest*, Nov. 6.

Standard Practice in Electrical Elevators. MOSES. *West. Elec.*, Dec. 18.—A reprint of the article noticed in the *Digest*, Dec. 18.

Steam and Electric Power. TAYLOR. *Elec. Eng.*, Dec. 9.—A continuation of his article noticed in the *Digest*, Dec. 11.

TRACTION.

Accumulator Traction. LIEG. *L'Eclairage Elec.*, Nov. 27.—A long abstract of the description of an experimental line in Cologne. The length of the line is about a thousand feet, and contains various curves and grades; the car carries 38 passengers and weighs when empty 6.5 tons, carrying 84 cells weighing 2.9 tons, making the total weight 9.4 tons; it has 2 motors of 8 horse-power each; the results of the tests are given briefly in a table. A comparison is made of the costs of operation of an accumulator and an overhead trolley line; it is found that an accumulator line could consume 1.5 times more energy than the trolley line without increasing the cost of the coal at the central station; it is concluded that accumulator traction is more economical, as the number of cars run is less and the stops less frequent; it should not be used on lines having long grades and steeper than 2 to 3 per cent.

Dresden.—Lond. *Elec. Rev.*, Dec. 10.—A table giving data for the overhead, accumulator and underground conduit system used in this city; the watt hours per car km are given and average between 420 to 560, being greatest for the combined overhead and accumulator system. The decrease in the number of accidents is also referred to.

Electric Railroad on Mt. Blanc.—Elek. Tech., Oct. 31.—A note stating that the construction of an electric railway on this mountain is now assured, as the authorities controlling this territory have granted a franchise for it, and a scientific commission is at present considering the scheme; in the year 1899 the portion upto Montavert, at the Mer de Glaces, is to be in operation. The line from Geneva to Chamounix, part of which already exists, is to be completed as an electric line.

Brussels. TRAVAILLEUR. *L'Eclairage Elec.*, Dec. 4.—A long, well illustrated description of the conduit system used in Brussels, which comprises a length of about 6 miles of double track.

Formulas for Tractive Effort in Train Acceleration Tests. WRIGHT; PATTON. *Eng. News.*, Dec. 23.—Communications concerning the discussion of the formulas.

Lightning Protection.—St. Ry. Rev., Dec. 15.—An illustrated description of a number of forms of lightning arresters; the article favors the proper distribution of arresters at intervals and the use of choking coils.

Cost of Power for Electric Railways.—St. Ry. Rev., Dec. 15.—A table giving the details of the cost per kw hour, the fuel, etc., for each of a number of months for the Metropolitan Elevated Railroad in Chicago and two other roads. These costs vary so much that a general average cannot be given here.

Operation and Maintenance of a Power House. DE GURCHY. *St. Ry. Rev.*, Dec. 15.—The first part of an article in which he describes some of the troubles which have occurred in his experience in power houses.

Flywheel in Power Houses. RAWORTH. *Amer. Mach.*, Dec. 16.—A reprint of his recent remarks, short notices of which were referred to in the *Digest* recently.

Trial of Motor Wagons for Heavy Traffic.—Eng. News, Dec. 23.—A long abstract of the table of results in the article in the *Genie Civile*, which was noticed recently in the *Digest*.

Mining Locomotives.—Sc. Am. Sup., Dec. 18.—Brief illustrated descriptions of several German forms of locomotives to operate with the overhead trolley system; the illustrations show but little more than the external appearance.

Double Deck Electric Car.—Eng. News, Dec. 23.—An illustrated description of one that is to be run on a suburban line at Chicago. It has two trucks, and the entrances are in the middle, having low steps; it is a modification of a type which has already been in use.

Storage Battery Traction at Ostend.—West Elec., Dec. 18.—A translation, with the illustrations, of the article noticed in the *Digest*, Dec. 11.

Metropolitan St. Ry. Co. in New York.—Power, Dec.—An illustrated description of the proposed power house, which is said to be the largest steam plant in the world.

Kansas City Feeder System.—St. Ry. Rev., Dec. 15.—A brief description of the feeder system of the Metropolitan St. Ry. Co., comprising 62.6 miles of trolley lines and five power stations.

Newcastle, Pa.—St. Ry. Rev., Dec. 15.—A brief illustrated description of this road.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Charging for Current.—Lond. *Elec.*, Dec. 10.—An editorial note on the method devised by Cooper and Schenk. "The basis of this tariff consists in proportioning the charge per unit according to the consumption per square foot of floor space," the charge varying from 8 cents per units for two units or upward per square foot per quarter, to 12 cents per unit for less than one unit per square foot per quarter; irrespective of this the charge for a consumer whose yearly account at the lowest rate amounts to $500, is 8 cents per unit; over and above these rates there is a sliding scale of rebates according to the aggregate annual output of the station; for every 100,000 in excess of 600,000 the above rates are reduced by half a cent.

Gas Engines in Central Stations. ROBINSON. Lond. *Elec. Eng.*, Dec. 10.—A reprint of a long report on the Leyton station, where it is claimed that very favorable results were obtained with a gas-producing plant and gas engines, together with the storage battery, the three-wire continuous-current system being used; the report contains tables and quite a number of curves; the cost of fuel per unit sold is only 1 1-3 cents, which is claimed to be very satisfactory for a period which does not include the months of November and December, during which it will be still further reduced.

Central Stations in Germany Financially Considered. LUX. *Zeit. fuer Beleucht.*—The third installment of his article (see *Digest*, Nov. 27); it consists of a full-page table of data for a number of stations not included in his previous articles; no comment is made on these.

Ground Plates for Lightning Arresters.—An article on a test of earth plates by Vesper, abstracted under Telegraphy, contains some information which may be of use in connection with lightning arrester ground plates.

Duesseldorf.—Elek. Zeit., Dec. 9.—A long extract of the official report of the operation of this station.

Washington. DRAPER. *Elec. Rev.*, Dec. 22.—A long description, without illustrations, of the new plant of the U. S. Electric Lighting Co. at Washington.

Paris.—L'Eclairage Elec., Dec. 4.—Extracts from the official report of the operation of the Clichy station.

Three-Wire Practice in England and America. LOMAS. *West. Elec.*, Dec. 18.— A reprint of the article noticed in the *Digest*, last week.

WIRES, WIRING AND CONDUIT.

Practical Notes on Construction of Overhead Lines. MONTPELLIER. *L'Elec.*, Nov. 20.—A continuation of his long serial (see *Digest*, Nov. 20) giving illustrated descriptions of poles and supports.

High Potential Insulators. PERRINE. *Elec. Eng'ing*, Dec. 15.—A long article devoted mainly to a description of the way in which porcelain insulators are made. The question of the voltage of electric transmission depends entirely on the character of the insulators and the way in which they are installed; the consensus of opinion points to the future use of porcelain exclusively, as it is not only stronger than glass, but if accidentally broken it is not necessarily shattered. The proper porcelain for insulation is that in which there is only that amount of glass present which is necessary to fill up the porosity of the silicate of alumina, as the greatest amount of strength consistent with nonporosity is then reached. A danger to be avoided in the choice of a porcelain insulator of great weight is the tendency toward the use of soft paste porcelain by manufacturers whose machinery is not powerful enough to compress the hard-paste clay to a sufficient density. The proper time to apply the electrical test is before the insulator has been glazed, as the glaze will mask the cracks as well as the porosity; the final inspection should turn upon the perfection of the glazed surface, which, however, can never cover the insulator completely, as the surface will remain rough where it is supported in the furnace.

ELECTRO-PHYSICS AND MAGNETISM.

Indicator of Electric Waves. RIGHI. *L'Eclairage Elec.*, Dec. 4.—An abstract of a paper from an Italian journal. If the voltage between two terminals in a vacuum tube is less than that necessary to produce a discharge, the tube becomes illuminated when it is in the presence of electric waves and a galvanometer in circuit shows a decided deflection, returning to zero.

Electric Discharges in Rarefied Gases. LAMOTTE. *L'Eclairage Elec.*, Dec. 4.—A continuation of his long serial, chiefly on the cathode rays and their energy; the spectra of the metallic vapors are also discussed.

Dielectric Properties of Liquid Mixtures. PHILIP. *Zeit. f. Elektrochemie*, Dec. 5; abstracted from the *Zeit. Phys. Chem.*, 24, p. 18.—He made researches with a number of liquids, including those which do not follow Maxwell's law.

Conductivity of Iron Oxides and Sulphides. ABT. *Zeit. f. Elektrochemie*, Dec. 5; abstracted with the table of results from the *Weid. Ann.*, 62, p. 474.—He measured the resistance of specimens of different ores, showing enormous variations; he suggests using magnetic for standards of high resistance.

150,000 Volt Arc.—Elek. Zeit., Dec. 9.—A reproduction of a photograph made by Steinmetz. The length of the arc was 35 cm, the frequency 125, the current 0.465 ampere and the energy 35.5 kilowatt; it covered a period of two seconds; it shows a series of irregularly shaped flames.

Electric Endosmos. DE VILLEMONTEE. *L'Eclairage Elec.*, Oct. 30, Nov. 13 and 27.—A continuation of his long serial, which is in the form of a treatise on this subject.

Magnetic Shielding. DU BOIS. Lond. *Elec.*, Dec. 10.—The first of a series of articles, in which he intends to give a fuller treatment of

the subject than has hitherto been deemed sufficient; this is made necessary by the spread of electric traction and the effect of the return current on physical instruments. He begins with an historical introductory, and then follows with the theory of spherical and cylindrical bilamellar shields, in which he assumes the permeability to be constant and single valued; as a measure of the shielding effect he uses the field ratio, that is the ratio of the external field intensity to the field inside of the inner shield, and this ratio will give the figure of merit of the shielding. The mathematical equations given are comparatively simple.

Magnetic Dip. Carlsheim; Gyllenskold. *Terrestrial Magnetism,* Sept., abstracted briefly, with the curve, in the Lond. *Elec.*, Dec. 10.—Folgheraiter some time ago made experiments with Etruscan vases, with the object of finding the magnetic dip during the Etruscan period; he proved that the magnetic dip is registered in the baked objects; his conclusions were that in the sixth, seventh and eighth centuries B. C. the dip in Italy was zero, or even negative. The present writer examined these results in the light of a formula involving spherical functions embodying all the observations of the last 400 years; the diagram is given. The formula does not agree with the above conclusions.

Errors in Magnetic Surveys. Wild. *Terrestrial Magnetism,* Sept.; abstracted briefly in the Lond. *Elec.*, Dec. 10.—He calls attention to some of the sources of error which are not always given the proper consideration; the brass of the instruments may contain considerable iron; the whole instrument without the needle should be tested with regard to the effect on a magnetometer, and every part should be tested separately; screws and other details have been known to produce errors up to six times the amount of the limit of observation. He recommends the abandonment of the dip-circle in favor of the introduction of the inclinometer; Lloyd's magnetic balance is the best for measuring the variation of the vertical intensity.

Cause of the Magnetism of Rocks.—Cosmos, Dec. 11.—An abstract of a paper from an astronomical journal in which the opinion is expressed that the origin of the magnetism existing in magnetized rocks in the earth is originally due to lightning discharges; examinations made by Pockel and by Folgheraiter are referred to and tend to prove this.

Roentgen Rays. Rollins. *Elec. Rev.*, Dec. 22.—A short article in which he states that Röntgen rays differ only in degree and are dependent for their penetrating power on the voltage and the degree of vacuum; the voltage should be so adjusted that rays of the proper wave length are generated for the specfic purpose; for showing the bones of the hand the voltage should be kept low; if the bones are deeply embedded the vacuum and the voltage should be kept the same and the light should be increased by more frequent impacts of the cathode discharge; if the voltage and vacuum are raised the proper distance between the cathode and anode is increased and the bones become relatively more transparent; by increasing both of these he believes all the elements would be as transparent as glass is to light.

Constitution of the Electric Spark. Schuster. *Sc. Am. Sup.*, Dec. 18.—A reprint of his recent British Association paper, which was noticed in the *Digest*, Sept. 11 and Oct. 2.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolytic Treatment of Sulphide Ores. Threlfall. *Elektrochem. Zeit.*, Dec. 1.—A long, illustrated description of the Ashcroft process, which is to be used in a large installation under construction at Cockle Creek, in New South Wales; it is said to be the first process of the kind which has been introduced into practice; it has stood a test in which 50 tons of ore were treated weekly. In this process the ore is finely ground and then roasted at a low temperature; it is then mixed with a solution of iron chloride containing some sulphate of sodium; the zinc oxide is thereby dissolved as chloride of zinc, the sodium sulphate preventing the solution of the lead; this is continued until the solution contains 30 grams of zinc per liter, after which it is cleaned, thoroughly oxidized and filtered, the liquid being then ready for electrolysis of the zinc; he obtained a hard, bright deposit of very pure zinc, the current density being 5 amperes per square inch; he uses iron anodes, which were dissolved, the two solutions being, however, separated by a diaphragm; the solution is only partially exhausted of its zinc and is then used over again. Importance is placed on Ashcroft's discovery that the zinc is deposited better from a basic solution; the solution is treated either with zinc oxide or an alkali. Illustrations of the plant are given.

Obtaining Nickel from its Ores by Electrolysis. Foerster. Lond. *Elec. Rev.*, Dec. 10.—An abstract of his article, which was noticed in the *Digest*, Oct. 16; see also Oct. 23.

Electrolytic Separation of Nickel and Cobalt from Iron. Ducru. *Elektrochem. Zeit.*, Dec. 1.—A brief abstract in German of the process noticed in the *Digest*, Oct. 16.

Electrolytic Separation of Antimony and Tin. Ost. *Zeit. f. Elektrochemie*, Dec. 5.—A reply and criticism of the recent statements by Waller (see *Digest*, Dec. 18).

Production of Iodoform. Foerster and Meves. *Zeit. f. Elektrochemie*, Dec. 5.—An article on the electrolytic production of this material.

Theory of the Low Voltage Current Between Polarized Electrodes. Salomon. *Zeit. f. Elektrochemie*, Dec. 5; noticed briefly from *Zeit. Phys. Chem.*, 24, p. 55.—He calculates the metallic conductivity of a certain electrolyte.

Temperature Coefficient of Calomel Electrodes. Richards. *Zeit. f. Elektrochemie*, Dec. 5; abstracted from the *Zeit. Phys. Chem.*, 24, p. 39. He made researches to investigate the very decided variations of the temperature coefficient of calomel electrodes in different electroyltes.

Progress in Electro-Chemistry in 1896.—Elek. Anz., Dec. 5.—The first part of an article giving a general summary of recent developments, more particularly in Germany.

Testing Storage Batteries. Kennedy. Lond. *Elec. Rev.*, Dec. 10.—After calling attention to the importance of mentioning the sizes of the cells tested, he shows a curve giving the relation between the kw hours, the rate of discharge and the weight, and with this curve it is possible to compare cells when they are of large or small size; the ordinates give the discharge rates in amperes and the abscissas the pounds per kw hour; these weight curves are nearly alike for all cells; the curve falls rapidly at first for a few amperes and then more slowly until it becomes nearly straight at about 100 amperes; the E. P. S. cells above 53 amperes begin to drop in weight at a constant rate of about 2 pounds per 15 amperes increase; for comparing cells they should be tested at similar discharge rates or reduced to similar ones by multiplying or dividing by the constants found from such a curve.

Notes on Accumulator Construction. FitzGerald. Lond. *Elec. Eng.*, Nov. 26, Dec. 3 and 10.—The continuation of his long serial. He discusses the Faure patents and in the latter installment the inventions of Volckmar, Swan and Sellon, from the historical standpoint.

Construction of Accumulator Plates. Weyer. *Elektrochem. Zeit.*, Dec. 1.—A long article giving brief, illustrated descriptions of a very large number of electrodes, taken apparently from patent specifications.

Storage Batteries. Wade. Lond. *Elec.*, Dec. 3.—A continuation of his serial, see *Digest*, Oct. 30; in the present installment he gives illustrated descriptions of different forms of grids.

Air as a Depolarizer. Lavison. *Zeit. f. Elektrochemie*, Dec. 5.—An illustrated extract from a patent, in which he proposes to use hot air as a depolarizer in batteries, the electrodes being mounted so as to revolve, the upper part being in the warm air.

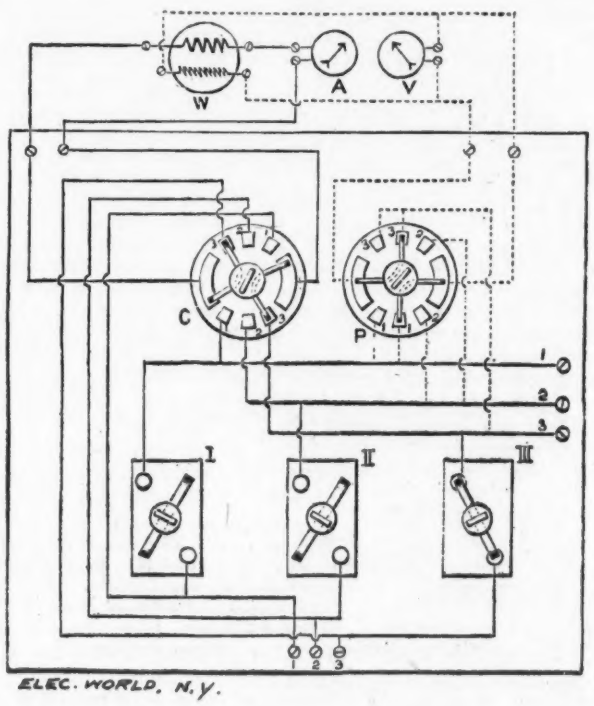
Electrotyping, Plating and Gilding. Warren. *Sc. Am. Sup.*, Dec. 18.—A reprint of an article giving a number of practical hints, receipts, etc.

Progress of Electro Chemistry and Electro Metallurgy. Andreoli. *Eng. & Min. Jour.*, Dec. 18.—A long abstract of the article noticed in the *Digest*, Dec. 11.

Electro Chemical and Electro Metallurgical Industries. Kershaw. *El'ty*, Nov. 17 and Dec. 1.—In this continuation of his long serial he gives industrial notes on the electrolytic copper industry and on aluminum

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring Three-Phase Currents. Fry. Lond. *Elec. Rev.*, Dec. 10.—An illustrated description of the method used at the Hanover Polytechnikum, which is very simple, beside being economical in the number of instruments and the time required; only two readings are necessary, their sum giving the power transmitted. The method



is applicable to both the star and the triangular systems; he develops the formulas for both; indicating the wires by numbers 1, 2 and 3, he shows that the power in both systems is equal to the voltage between 1 and 2 multiplied by the current in 3, plus the voltage between 1 and 2 multiplied by the current in 2. The arrangement of the switchboard for doing this is shown in the accompanying diagram, in which all connections are permanent; the 3 terminals at the

bottom lead to the generator and those at the right hand side to the consumer of power; the dotted lines are those for the voltage measurement; the wattmeter, ampere meter and voltmeter are shown above; the two switches C and P are turned in order to make the two readings.

Testing the Insulation of Alternating Current Installations. WILKENS. *Elek. Zeit.*, Dec. 9.—A short article in whcih he points out the advantages of a simple method of making these measurements with the Weston instruments, when the continuous current is used, and shows that for the alternating current other methods become necessary, as the sensitiveness of these instruments is not sufficiently great; he tried the well-known bridge method, using the telephone, which system he describes in detail; with the usual frequency, however, the telephone was not sufficiently sensitive; better results were obtained with a small induction coil; with the galvanometer and battery the method gave very good results for telegraph wires, but he had to abandon the method for testing house connections. The reason why the alternating-current voltmeter is less sensitive is that the field cannot be made strong; this defect he overcomes by creating a strong field in the instrument, by means of a coil through which a constant current flows (the current being presumably alternating); on this principle he constructed an alternating-current voltmeter, which answers the purpose of measuring the insulation by unskilled persons in a very short time.

Electrical Testing for Telegraph Engineers. YOUNG. Lond. *Elec.*, Dec. 10.—A continuation of his long serial; it is in the form of a practical treatise describing the methods of testing used by telegraph engineers.

Recording Instruments.—L'Eclairage Elec., Dec. 4.—A brief illustrated description of the Siemens & Halske instrument, in which the position of the deflecting needle is recorded periodically by pressing a point at the end of the needle into the moving paper.

Magnetic Observatory.—Cosmos., Dec. 11.—An illustrated description, including views, of the interior of the new magnetic observatory at Parc Saint-Maur, near Paris, France.

Our Knowledge of the Value of a Resistance. AYRTON. *El'ty*, Dec. 22.—A reprint of the article abstracted in the *Digest*, Dec. 18.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Tests of Earth Plates. VESPER. *Elek. Zeit.*, Dec. 9.—A reprint of a long paper giving the tabulated results of systematic tests made during a period of five years for the German Government telegraph department; it appears to be the most complete series of tests of that kind which has been published. After showing how little information exists, and that what information there is was obtained from isolated cases, he describes his tests; a number of differently formed earth plates made of different materials were buried in a piece of ground where all other conditions were similar, and their electrical resistances were then measured periodically; they were 2.5 metres apart; under the upper layer of the ground there was a uniform hard layer of coarse sand extending to a great depth; the ground water was 2.6 m below the surface; only the more usual forms of electrodes were used, the materials being iron, copper, lead and coke; fourteen different earth plates were made, almost all of them having a surface of 1 sq. m., and most of them being below the surface of the ground water; they are all described in a table. The final method used for measuring the resistance was a bridge method in connection with the telephone, the resistance being measured between each pair of electrodes, and from these the resistance of each of the single electrodes was calculated; the results are given in detail in a large table. The height of the ground water does not produce the variations in the resistance which would be expected, but in general the highest resistance corresponded with the lowest level of the ground water; in those electrodes above the ground water the variations were very great; the latter have about 2.5 times the resistance of those under the ground water; the material of the tubes has almost no effect on the resistance, although the copper appears to show an increase and the lead a decrease in the resistance; which material is the best can only be seen later when the electrodes will be dug up again; the improvement produced by coke is very great in the electrodes above the ground water; the resistance of those with tubes was much more constant than those with nets. In order to test the effect of coke more thoroughly, including the effect of the shape and size of the mass, six more electrodes were buried in 1893; the centre of gravity of the mass was one metre below the surface; as the electrodes will then be more rapidly destroyed it is preferable to use iron rods for electrodes, which can easily be driven into the ground through the coke, and, therefore, very easily renewed. He found that the metal electrode must be at least a certain size, and that more than this did not improve it; coarse coke was better than the fine sifted material; five other tests were made with different areas of electrodes in beds of coke; in a summary of the results the maximum, minimum and mean values of the resistance in each case are given; the lowest average appears to be 4.9 ohms for a galvanized iron tube in ground water, and the highest average 53 ohms with an iron tube in dry earth. He appears to conclude that the best form is an iron cable in a bed of coke, but if this has too short a life, an iron tube in a bed of coke is to be recommended, the resistance being somewhat higher; several rods can be used in the same bed; cables in coke will be used by that department where ground water cannot easily be reached. In the discussion Neesen stated that the life of the electrodes was the most important consideration. Vesper replied that no change was noticed during the five years. Klingenberg called attention to the polarization phenomena. Wurstemberger claimed that this polarization would have no effect on the measurements, because they were made with an alternating current. Benischke doubted this, as the two alternating curents were then of unequal strength.

Wireless Telegraphy. POPOFF. Lond. *Elec.*, Dec. 10.—In a communication on the application of the coherer, he quotes from his paper read before the Russian Physical and Chemical Society, in April, 1895; he first described a coherer made of two platinum leaves inside of a glass tube about 1 mm to 2 mm apart, to be used in connection with iron filings; together with an electric bell and an automatic tapper, the apparatus formed a detector of electric waves; since 1895 it has been used as a recorder of atmospheric discharges in the meteorological observatory of St. Petersburg; he also expressed the hope that the apparatus would be applied for signalling to great distances as soon as a more powerful generator was invented; he detected electro-magnetic waves at a distance of 5 km. at that time. He now claims that Marconi's receiver is a reproduction of his lightning recorder.

Hertian Telegraph in France.—Lond. *Elec. Rev.*, Dec. 10.—An abstract of a recent paper by Ducretet before the French Physical Society; the anticipations to Marconi's system are mentioned. The account is reprinted in *El'ty* (N. Y.), Dec. 22.

Lighthouse and Light Vessels.—Lond. *Elec. Rev.*, Dec. 10.—The conclusion of the reprint of the commissioner's report on the subject of the best means of communication.

Telegraphy. HESS. *L'Eclairage Elec.*, Dec. 4.—A continuation of his description of the Delany system and the synchronograph..

Iron in Telephony. WIETLISBACH. *Elec. Eng'ing*, Dec. 15.—A short article on the magnetic behavior of iron with special reference to its use in telephony. The laws of magnetization and hysteresis are described, and the importance of studying these properties in connection with the construction of telephonic apparatus is given; in an iron core for telephonic apparatus, for instance, the magnetization should respond quickly, and the core should therefore be relatively short and composed of fine wires, being, of course, as soft and homogeneous as possible.

Telephone System of the United Kingdom. RAPHAEL. Lond. *Elec.*, Dec. 10.—A continuation of his long serial describing the systems used in that country.

Development of Multiple Systems for Large Telephone Central Stations. HELLRIG. *Zeit. fuer Elek.*, Nov. 15.—A continuation of his long article, noticed in the *Digest*, Dec. 4.

Efficiency of Translators. REDING. *Elek. Zeit.*, Dec. 9.—The conclusion of the German translation of the article referred to in the *Digest*, Oct. 23 and Nov. 27.

Office Telephones. WEST. Lond. *Elec.*, Dec. 10.—A brief abstract of the article noticed in the *Digest*, Dec. 11.

Revolving Field Signalling. ARLDT System. *L'Eclairage Elec.*, Dec. 4.—A well illustrated description of the system of signalling by means of a revolving field, which was described in the *Digest*, Sept. 18.

Signalling Through Space without Wires. PREECE. *Science*, Dec. 17.—A reprint, with illustrations, of a recent Royal Institution address describing his system and that of Marconi. It seems quite similar to the address which was noticed some months ago.

Secondary Telegraph Calls. MONTILLOT. *L'Elec.*, Sept. 11, 25, Nov. 13 and 27.—A continuation of his long serial, the beginning of which is noticed in the *Digest*, Sept. 18.

MISCELLANEOUS.

Gutta-Percha from Leaves.—Elek. Tech., Nov. 30.—A note on what is called "green gutta-percha," which is extracted from the leaves of the plant, in which it is stated that the advantages are that the purchaser can always be guaranteed the same quality, and that the work of refining, which increases the first cost 15 to 20 per cent., is entirely saved. It is also stated that the Government telegraph department in France, in order to test this quality of gutta-percha, has constructed a submarine cable with which very careful experiments were made; these show that the capacity and insulation of this gutta-percha gave better results as compared with other first-class gutta-percha.

Gutta-Percha or Rubber as an Insulator. SCHULZE. *Elek. Tech.*, Oct. 15.—A reprint of a short article from a German rubber journal. He claims that the use of gutta-percha for insulating purposes is diminishing quite appreciably, and is being replaced by rubber; the construction of rubber cables is claimed to be a profitable and rapidly increasing industry.

Electric Furnaces. HORRY System. Lond. *Elec.*, Dec. 10.—A brief editorial reference. The chief defects of the present calcium carbide furnace are that the process is not continuous, and the voltage is constantly varying on account of the change of the resistance; these defects are claimed to be overcome by this furnace, which is an open hopper suspended on standards so that the lower ends hangs over the space between two carbon electrodes where the arc is formed and between the flanges of a rotary spool or reel, to which a movable cover plate can be attached; the carbons rest on the fireproof material of the hopper; the length of the arc is thus kept constant; the mixture is fed in at the top, and when the ammeter shows that the current rises, the spool is rotated to remove the product. The description is not very clear, and no illustration is given. The note is reprinted in *El'ty* (N. Y.), Dec. 22.

Ozone Generators. Andreoli. Lond. *Elec. Rev.*, Dec. 10.—A communication in which he claims great advantages for pointed electrodes as against flat plates, the former giving at least 20 per cent. more ozone. For the best results the electrodes should not be charged as highly as possible, as was recently claimed by others; there should be no sparks, but a silent discharge; he has obtained more than 100 grams of ozone per horse-power hour with point-bearing electrodes.

How to Become an Electrical Engineer.—Elec. Rev., Dec. 22.—An article written for that journal, to which the second prize was awarded. It contains also a list of "colleges" (many of them, however, are merely schools) at which are given courses in electrical engineering, including also the name of the professor of either that subject or physics.

Biographical.—West. Elec., Dec. 18.—A biographical notice, with a good portrait, of the late Gardiner Green Hubbard.

The Digest for 1897.—During the past year the number of journals abstracted in this department was 1629, averaging a little over 31 per issue; of these, 865 were foreign and 764 American. The number of abstracts and references was 4169, averaging a trifle over 80 per issue; last year the total number was 3333, showing a considerable increase. The largest number in one group was 794, under Electro-Physics and Magnetism; next comes Traction, with 570, followed by Electro-Chemistry and Batteries with 465.

The Digest for 1898.—The more important articles of the week will hereafter be abstracted more fully, and in order to obtain necessary space for this, the references to the less important matters, notes, etc., or to articles on allied subjects, but belonging more properly under pure physics, chemistry, mechanical engineering, medicine, law, etc., will in general be omitted. References to translations of articles from foreign language, or to reprints in an accessible journal of articles originally appearing in an inaccessible one, will be given as heretofore. Abstracts of articles in easily accessible journals will be made more brief. Articles appearing in The Electrical World are not again noticed in the *Digest.*

Book Reviews.

A DICTIONARY OF ELECTRICAL WORDS, TERMS AND PHRASES. By Edwin J. Houston. Fourth Edition. Greaty enlarged, 5218 words, terms and phrases, being newly added. Royal octavo. Cloth; 990 double column pages, 582 illustrations. New York. The W. J. Johnston Company, Publishers, 253 Broadway. 1898. Price, $7.

This fourth edition of Professor Houston's encyclopædic work has been brought down to the year 1898 by the addition of over 320 pages of new matter. In the added portion the author discovered that such a marvelous growth in the electrical vocabulary had taken place that it was not desirable to insert, as a separate appendix, the new words, terms and phrases alone. Hence an appendix was prepared, including all the words, etc., to the number of just 10,042, and these with concise definitions form the added matter. For further detail the reader is referred to the encyclopædic and illustrated matter in the front of the work.

The vast and unparalleled growth of the electric arts is reflected in the remarkable expansion of this volume with succeeding editions. The first edition, of 1889, had 657 pages, each about half the size of those of the present edition, and contained less than one-third the amount of text. In the edition of 1889 about 2100 words, terms and phrases were defined. In 1892 the number had grown to 3820, which, in the edition of 1894, were increased to 4824. This edition of 1898 contains definitions of no less than 10,042 words, terms and phrases, nearly 600 illustrations, and a vast amount of electrical information.

It is hardly necessary to dwell upon the merits of a book so well and widely known as this dictionary. Its completeness is remarkable. Included in the new work are many terms of very recent origin, such as "coherer," "Marconi rays," "sciagraph" and the whole technology of Röntgen rays.

The book is handsome and substantial, the typography clear and legible.

PRACTICAL CALCULATION OF DYNAMO-ELECTRIC MACHINES. A Manual for Electrical and Mechanical Engineers and a Text Book for Students of Electro-Technics. By Alfred E. Wiener. Cloth. Large octavo. 750 pages, 372 illustrations and 105 tables. New York: The W. J. Johnston Company, Publishers, 253 Broadway. 1898. Price, $2.50.

This admirable volume develops an entirely practical treatment of dynamo calculation different from the usual text book method in which the application of the given formulæ requires a certain experience in dynamo design. This book undertakes to give such experience. Data of over 200 representative American and foreign dynamos are given in the shape of tables and formulæ, presenting for the first time an absolutely practical work. It is a book to use in the shop as well as the school, and Mr. Wiener is to be congratulated upon having produced so eminently timely and valuable a work.

The arrangement of the contents is with regard to the natural sequence of the subject. The length and size of armature conductors is first taken up, then the arrangement of these conductors upon a suitable armature is discussed, considerations of the magnet frame and its winding following. The results throughout are given in the metric system as well as in the ordinary English inches, feet, pounds, etc.

A refreshing fact about the book, and one that ought to commend it, is that it is not filled with a long discussion of the theory of electricity or a number of antiquated illustrations of dynamos. The illustrations are almost all new and bear directly upon the text. The mathematical treatment is sensibly limited to simple algebra.

The book fills a vacant place, and will be found of practical usefulness to the mechanic, the engineer, the student and the teacher.

AN INDEX TO THE ELECTRICAL WORLD from 1883 to 1897. Published by the W. J. Johnston Company, 253 Broadway, New York. Cloth; octavo; 372 pages. Price, $8.

This work is a complete index of The Electrical World proper, giving references to every article published in it for fourteen years past, including the paragraphs of the Digest. In this way it forms an index of periodical electrical literature of the very greatest value. Used in connection with a file of The Electrical World it must prove an invaluable addition to the tools of the working engineer, enabling ready reference to descriptions of installations and inventions, and the greatest mass of original literature on electrical subjects. The book is well made, being strongly and substantially bound and very clearly printed. The edition is limited to 500 copies.

Lightning Protector and Railway Telephone Outfit.

The Viaduct Manufacturing Company, Baltimore, Md., has recently brought out two new electrical appliances, which will meet a demand in their particular field, namely, a new form of lightning protector and an electric railway telephone outfit.

The lightning protector (Fig. 1) consists of three metal plates with serrated

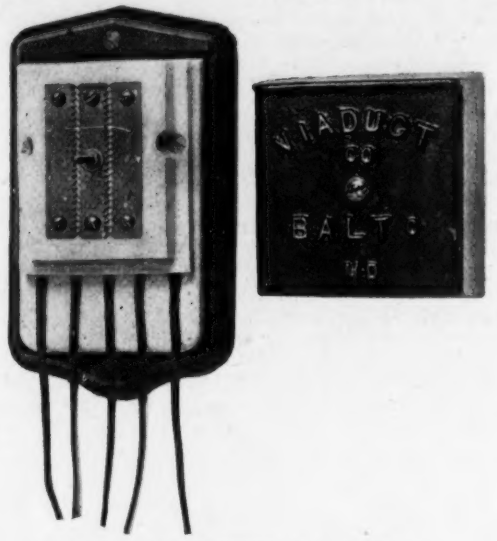


Fig. 1.—Lightning Protector.

edges. The plates are screwed to a porcelain block, which is provided with a substantial cover to protect the plates from mechanical injury and admit of ready access for inspection and repairs. The plates are arranged after the manner of the earlier lightning arrester, which form has proved to be a very

Fig 2.—Railway Telephone Outfit.

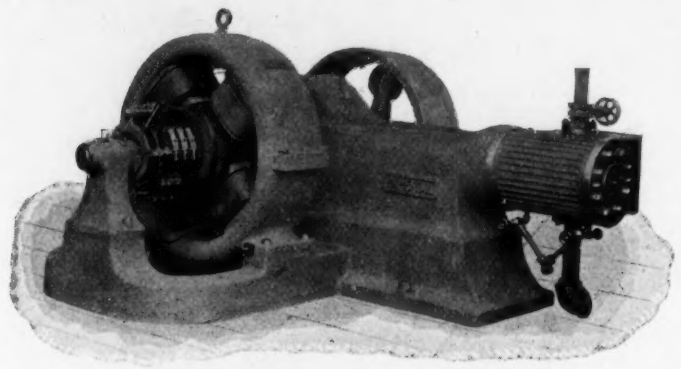
good one for comparatively small currents. The device is very neat in appearance and compact.

The police, fire alarm and trolley telephone outfit (Fig. 2) is said to meet all the requirements in the lines indicated in the name. It is being extensively used for electric trolley railroad purposes, and is reported to be giving first-class satisfaction. It enables the motorman at any place along the road to signal and communicate with the central station, and the central station can in turn signal and attract the attention of the motorman of a car passing any of the boxes along the road, and communicate with him. This is done by the con-

tinuous ringing of a 6-inch vibrator bell until the attention of the motorman is called, the box opened and communication with the central office established. The outfit is placed in a heavy iron weather proof case with trap lock, and the whole outfit is gotten up in the best possible manner.

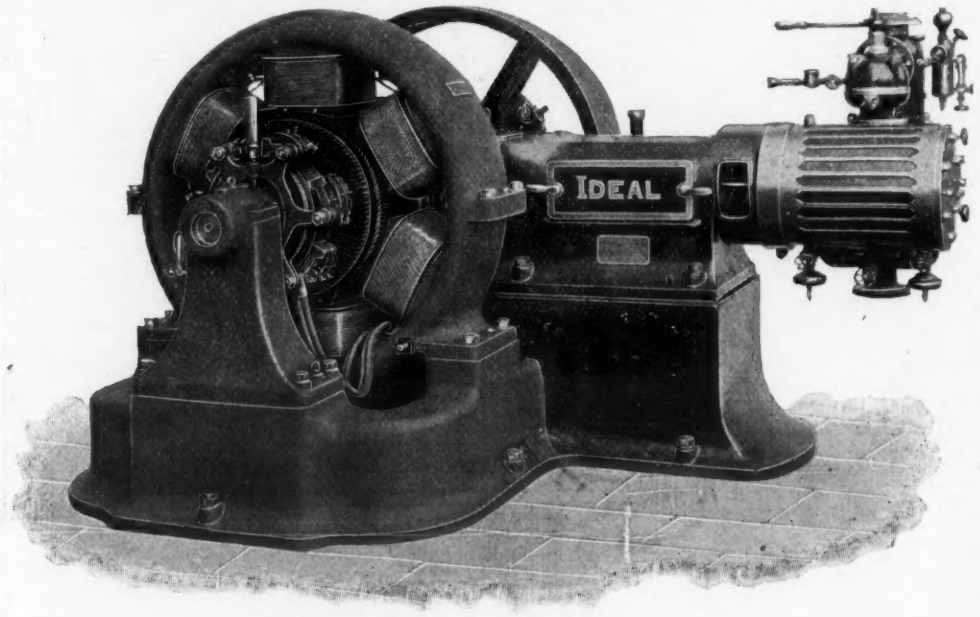
New Multipolar Apparatus.

We illustrate herewith the new Akron multipolar apparatus, manufactured by the Akron Electrical Manufacturing Company, Akron, Ohio. The dynamo has a cast-iron field yoke, with laminated steel magnet cores cast therein, and tipped with soft steel pole shoes, thereby giving an ideal magnetic and structual condition. The laminated cores having a great capacity for magnetism respond readily to the magnetizing influence of the coils, while the cast iron makes a perfect welded joint between the cores and yoke, the yoke having a considerable cross section. The soft steel pole shoes distribute the magnetic lines evenly over the armature's surface, while the field cores are kept as small as is compatible with efficient results, so as to reduce the copper losses in the field as much as possible. The armature is built up of unusually fine laminations of soft steel divided into three or more sections by small brass spacers having radial arms to create a blast of air through the core openings thus formed, and across the armature winding. The spider which carries the core is of cast iron, with radial arms arranged to admit air freely through the ends



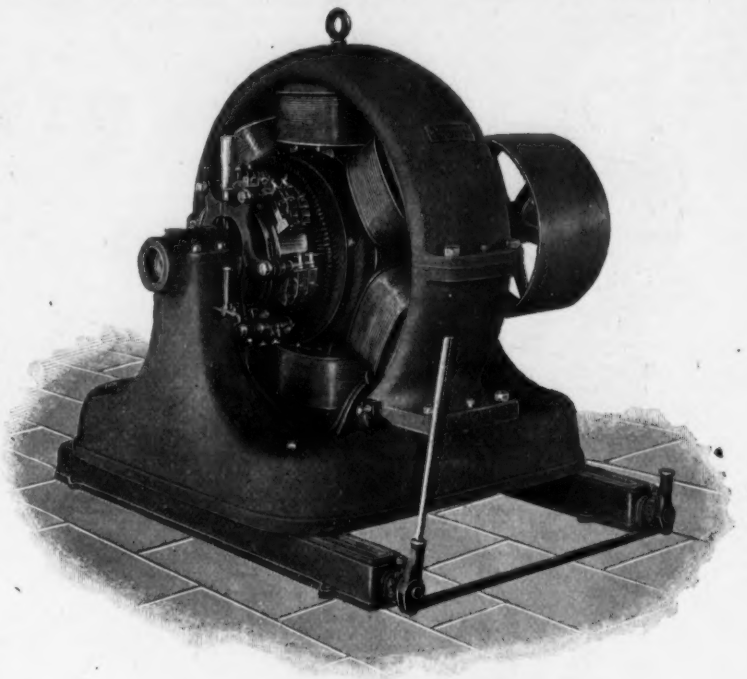
DIRECT-CONNECTED FOUR-POLE UNIT.

of the armature, and force it swiftly through the passages formed by these spacers and the end flanges, which are also provided with radial passages for the air. This construction ventilates the armature perfectly, increases the radiating capacity and reduces the temperature far below the safe limit, thus allowing of heavy and continued overloads without injury to the dynamo. Machine formed armature windings are perfectly formed, then insulated by hand and embedded in troughs made of mica, paper and press board in the armature, and the ends connected to the commutator, which is made up of drop-forged copper bars, with India mica insulations put together at a high temperature and under enormous pressure, so that when once assembled and turned true it is impossible to move the bars when struck a sharp blow with a heavy hammer. Radial feed carbon brushes are connected at the top by means of flexible copper



DIRECT-CONNECTED SIX POLE UNIT.

strips to the body of the brush holder, thus making a positive metallic circuit through them and the brush holder cables from the commutator to the dynamo's terminals. The bearings on the belted units are self-oiling and self-aligning, securely held in pedestals cast integral with the base frames, and provided with sliding base rails having convenient ratchet screws attached to tighten and loosen the belt. The generators are, taken as a whole, neat and pleasing in design, thorough in construction and so conservatively rated that they may be operated continuously under 25 per cent. overload, with temperatures not exceeding 50 degrees C. above the surrounding atmosphere, and with temporary overloads of 50 per cent. without injury in any way. They are made

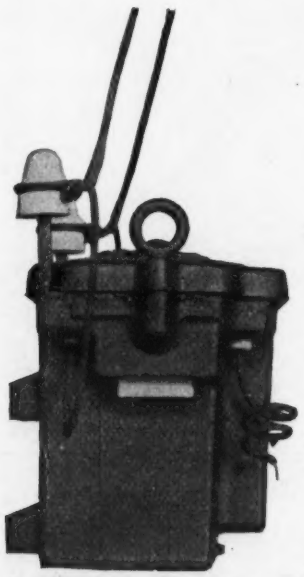


BELTED UNIT.

for direct connected, slow and moderate speeds, and range in size from three-quarters kilowatt up to 300 kilowatts in the generators, and from one horse-power to 400 horse-power in the motors.

A New Type of Stationary Transformer.

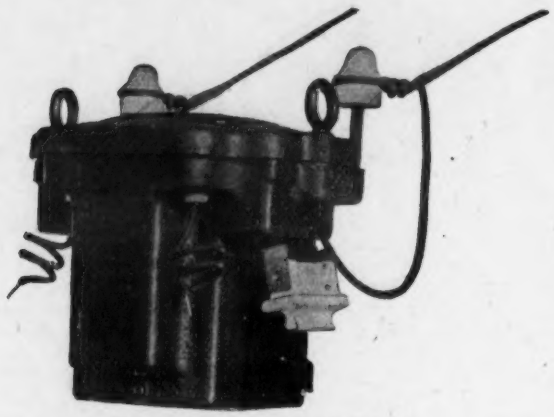
The last year has developed a much keener appreciation on the part of station men of the vital necessity of good transformers for central station distribution, and a demand has gradually appeared for increased operating efficiency in these instruments. The main end held in view by designers of transformers is a general decease in the internal losses. The most desirable decrease is in core losses, or the losses which take place in the iron core of the instrument, and go on without interruption day and night, whether or not power is withdrawn from the customer's side of the converter. In other words, a high all-day efficiency is the principal consideration which should govern the proper design. The losses in the copper of the transformer are due to the resistance of the two circuits contained in it, and do not make themselves felt until the instrument



TYPE G TRANSFORMER, SIDE VIEW.

is called into use, when they increase with the square of the load. Depending upon the design of the instrument these may be made large or small, but they are almost never so important as the continual iron losses. Regulation is the feature next to high efficiency generally claimed by manufacturers of transformers, but to obtain the highest regulation requires in most cases a sacrifice of other desirable qualities. While good regulation is essential to the successful operation of these machines, it avails little to put a transformer regulating with

great accuracy upon circuits having large drop, and connected to dynamos which vary sometimes several per cent. With a transformer that has a reasonable full load *C R* drop, say 3 per cent., an attempt to decrease the variation between full load and no load to 1 per cent. would require the resistance



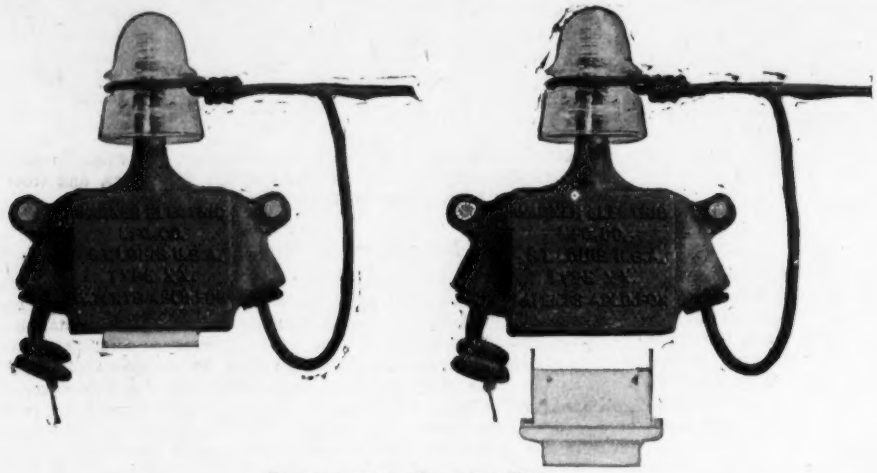
Transformer with Cut-out.

This transformer, whose construction is shown clearly in the illustrations, is made with great care, and every precaution is taken to guard against leakage from coil to coil or coil to case. Each is tested between primary and secondary and each coil and the case at a pressure of 0000 volts for the dry transformers,

Ten kw. Transformer without Fuse Cut-out.

to be cut down to one-third. This means, if the instrument is not to be made much larger, a decrease in the number of turns in each coil, so that wire of larger size and less resistance may be used. The effect of decreasing the number of turns would be to immediately increase the strength of the magne-

and 10,000 volts for those filled with oil, before they are sent out. The use of oil in transformers is strongly advocated by this company. Not only is its superiority as an insulating agent manifest, but it greatly assists in distributing the heat generated within the instrument, and thus in keeping it cool. These in-



Independent Cut-out Box.

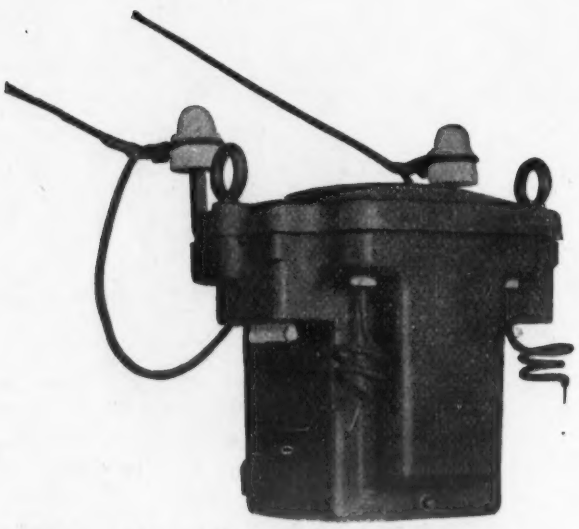
Transformers without Case.

tization of the core, and consequently increase the iron losses. Such a change, while benefiting the regulation, might make a poor transformer out of a good one.

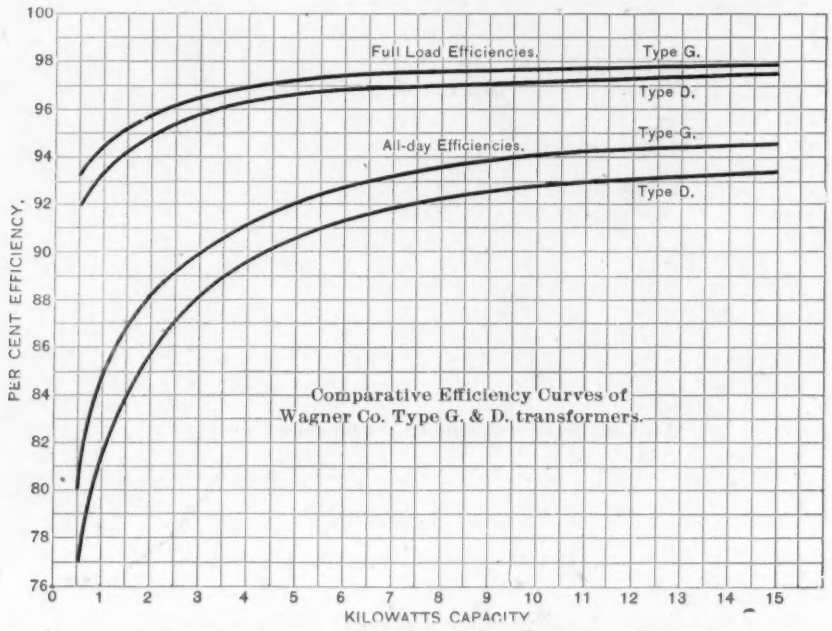
The Wagner Electric Manufacturing Company, of St. Louis, Mo., in bring-

struments are said to withstand the aging effect which has been noticed in most transformers, due to the fact that iron subjected to the strain of an alternating magnetic field seems to gradually change its magnetic qualities.

These instruments, which represent the highest class of modern design as



Corner View of Transformer.



Efficiency Curves of Types D and G Transformers.

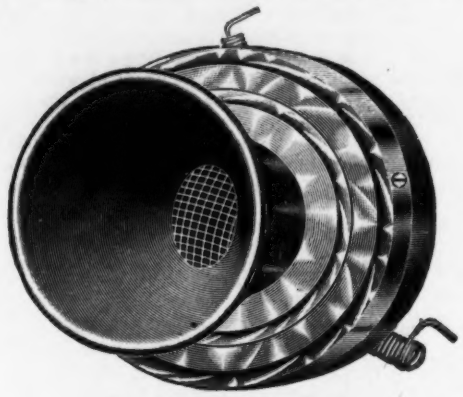
ing out its "Type G" transformer, which is illustrated herewith, has endeavored to meet the requirements above mentioned, and unite a high all-day efficiency with close regulation, high efficiency at various loads and superior mechanical design.

applied to such construction, are made in sizes from 500 to 15,000 watts (10 to 300 lights) for 1000 and 2000 volts, 60 and 133 cycles. They are furnished, when desired, with connections adapting them to be connected to primary voltages of either 1000 or 2000, as may be necessary. This is a great convenience in

stations operating at two pressures when it becomes necessary to change over a transformer from one set of lines to another.

The line of transformers is made in two forms, in one of which the fuse cut-outs are attached in all sizes up to 100 lights; the other without cut-outs. The independent cutout used is of the single pole form, the fuse being carried in an air-tight tube within a removable porcelain plug, which allows an easy refusing without risk of shock. The best protection from lightning is probably effected by a high puncture resistance between the primary and secondary coils. Some engineers, however, prefer a grounded metallic shield between the two coils in order to absolutely prevent any high difference of potential between the main and the secondary circuit. This type of transformer is made up with these shields when specified, but they are not recommended.

Transformers, especially for residence service, are occasionally called upon in times of evening festivity to carry a load enormously greater than even their average evening load. If a transformer is put in with sufficient rated capacity to carry this occasional load, which may not come on more than once or twice a year, its all-year efficiency will be lower than it ought to be. The Wagner transformers can be safely overloaded 25 per cent. for a period of three hours



IMPROVED TRANSMITTER.

MECHANICAL DENTAL ENGINE.

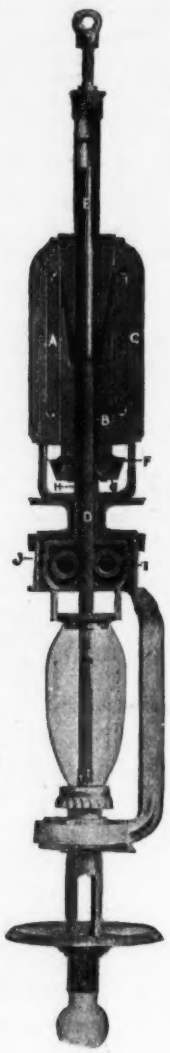


FIG. 1.

without damage, thus allowing the installation of transformers with a rating considerably below the maximum load which may be applied to them.

The Wagner Company encourages careful testing of transformers on the part of central station men, and to that end has a set of instruments which it recommends for use in such work. The most important tests for the user are, of course, those of no load loss and regulation, and any central station man can obtain precise information as to the instruments needed and the modus operandi of such tests by writing to the Wagner Electric Manufacturing Company.

An Improved Telephone Transmitter.

The telephone transmitter manufactured by the Kokomo Telephone & Electric Manufacturing Company, Kokomo, Ind., is claimed to be a most satisfactory instrument in actual service. It can be used over long distances, as well as on short lines, and talks equally well in either case for the reason, the manufacturers claim, that it has only one-fifth the resistance of transmitters of other makes. Its articulation is said to be practically perfect, sputtering and other disagreeable noises being entirely absent.

The Kokomo telephones are adapted to such special service as mining and electric railways, besides their general application. The transmitter illustrated above, which was patented on November 17, 1896, it is stated is entirely non-infringing.

In addition to the manufacture of telephones, the Kokomo Company produces telephone switchboards and all the necessary apparatus for the complete equipment of an exchange.

A Mechanical Dental Engine.

The Wheeler Electric & Manufacturing Company, Dayton, Tenn., is manufacturing a novel dental engine, which differs from apparatus of this class heretofore placed upon the market in that it depends upon mechanical means for controlling the speed of the dental drill. A small electric motor of special design, carefully adjusted for light running, furnishes the power. The novel feature, however, is the mechanical device for regulating and controlling the speed of the dental drill, which instantly stops, starts and reverses the drill, independently of the motor armature. It is simple in construction, and may be operated by anyone not possessing a knowledge of electricity, since the operative parts are purely mechanical. It is designed to run from battery or incandescent light circuits, either alternating or direct current.

Enclosed Arc Lamps.

Since the introduction of the commercial arc lamp in 1878 no improvement has been made in its development that can compare in commercial value with the enclosed arc principle. The used of the enclosed arc has practically revolutionized the arc light industry, and one of the earliest and most successful lamps of this character placed upon the market was the Jandus double inclosed arc lamp. This lamp, which is manufactured by the Jandus Electric Company, Cleveland, Ohio, has been before the public for the past three years, both in this country and Europe.

The Jandus lamp burns directly across the terminals of a potential circuit without waste of energy. This makes it desirable for a street lighting system where multiple circuits are used, and for an underground system it is particularly adapted because lamps can be connected wherever necessary without

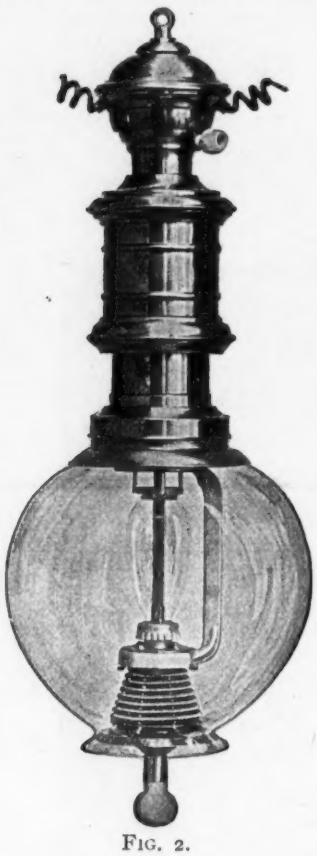


FIG. 2.

FIG. 3.

the inconvenience of running connecting wires between pairs of lamps or installing two lamps where only one is needed, or wasting the energy of one lamp, as was necessary under the old system of connecting two lamps in series. For interior lighting the economy and convenience of burning lamps singly cannot be overestimated. The Jandus lamp has been highly indorsed by the Board of Fire Underwriters generally. Mechanically and electrically it differs greatly from any other lamp.

The action of the lamp is extremely simple. There is only a single winding which forms the solenoid, shown in section at *A*, Fig. 1. The armature, *B*, is held suspended in a strong magnetic field formed by the iron frame, *C*, of the lamp, which surrounds the winding. The regulation of the lamp is maintained by the weight of the armature, which is considerable, opposing the pull of the magnet. When the arc becomes too long from the consumption of the carbon the magnet will weaken, owing to the decrease in the current flowing through it caused by the increased resistance of the arc, and the armature will fall a little until the arc has regained its normal strength, and the current consequently restored, when the magnet will again hold the armature stationary. The armature is the plunger for its own dash pot, formed in a brass tube inside the coil. The carbon, *D*, extended by a tube or sheath, *E*, is inserted directly into the clutch, consisting of a pan-shaped piece, *F*, carrying four clutch rings, *G*, which fall by gravity and grip the carbon between the inclined side of the pan and the carbon. The clutch releases this and allows the carbon to feed when the armature has descended, until the clutch rings rest upon the releasing tube, *H*. This form of clutch allows the unequal sizes of the carbons and sheath to be fed through it with equal accuracy. The current is conducted to the carbon through a series of sixteen contact rings, *I*,

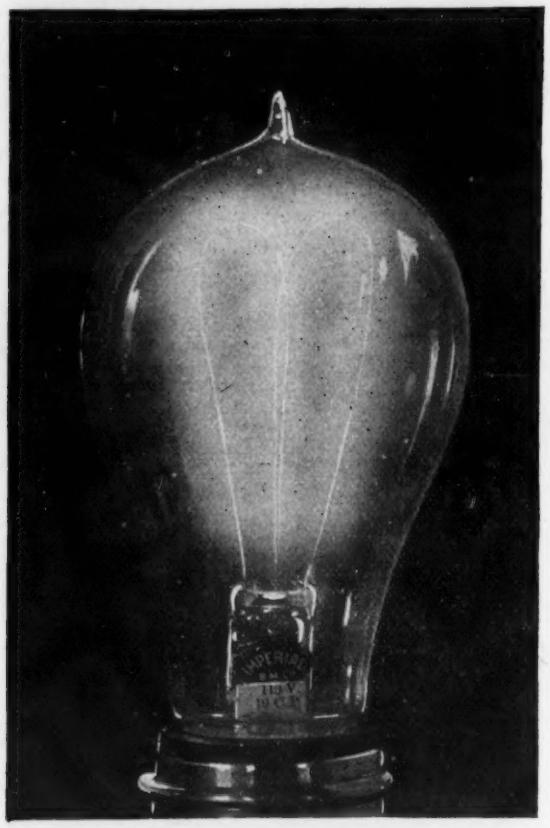
which are arranged in a circle and make a flexible contact with the carbon. One of the great advantages of the absence of the carbon rod is that the current is conducted from the mechanism directly to the carbon. The upper carbon is held concentric with the lower by the globe cap which is centered by the guides on the bottom of the box inclosing the contact rings. The armature carrying the clutch is therefore the only movable part in the entire mechanism of the lamp, the absence of springs or adjustments being one of the most notable features. The yoke, *J*, supports the inner globe and the lower carbon holder at its bottom end, where a ring admits the arms of the spider carried on the lower holder. This spider, by a turn to the right, locks the holder in position and closes the electrical circuit through the lamps. The outer globe is secured to the yoke at *J* by a circular nut, and is closed air-tight at this point by means of asbestos gaskets.

Fig. 2 illustrates the Jandus standard lamp for outdoor service. This lamp is provided with a waterproof case, and the terminal wires are led through water-tight rubber bushings, no hood being required. The rheostat is placed below the lower carbon holder inside the outer globe in a position where it will cast no shadow, and is thoroughly protected from the weather and readily accessible. This lamp is furnished in any style or color of finish desired. The lamp for inside service is shown in Fig. 3. The rheostat is placed in a canopy at the top of the lamp, where it can be readily adjusted by dropping the top half of the canopy. A cut-off switch is provided in the canopy. These lamps also are furnished in any desired style or color.

The Jandus lamp embody the following advantages: Long life (the lamps burning 150 hours on a single half-inch carbon); lamps burn singly with economy on 110-volt circuit; perfect diffusion and uniform distribution of light; absence of flickering; practically noiseless in operation; fewness of working parts; decrease in cost of repairs, and small size.

Double Filament Types of Incandescent Lamps.

A new double filament lamp possessing many advantages has recently made its appearance. While examples of such lamps have not been lacking in the past they have generally been considered specialties rather than standards on account of the high cost of manufacture and the difficulty of construction caused by the two 8-cp filaments being placed in series. Under these circumstances the slightest difference in the specific resistance in the carbons becomes quickly apparent, causing the two filaments to give varying amounts of light and necessarily shortening the life of the lamp. The same current passing



Double Filament Lamp.

through both, the carbon having the lowest specific resistance of course burns at a lower temperature than the other. Such lamps have been used as expedients where either it was desirable to have short bulbs, as in decorative work, or short stiff filaments, as in the case of lamps for railway cars and other situations where there is much vibration. Their manufacture in general has been approached rather for the obviation of mechanical difficulties than for any technical reason, and the quality of the resultant product has not as a general thing been high. In the new type here illustrated, which is manufactured by the Bryan-Marsh Company, New York, it was intended by the design to secure a better lamp. Mechanical advantages were deemed by the manufacturers as of only secondary importance when compared with the combination of long life and high sustained candle power. Since the double filament type alone was available for such employment it was adopted, and a long range of experimental work covering many months was undertaken. It has generally been thought impossible heretofore for high candle power area and long life to coexist, since the life was naturally shortened as the temperature of the carbon was elevated. It is claimed for this new lamp that, due consideration being given to efficiency, the life is increased about 10 per cent., while the sustained brilliancy is very great. This has been brought about by changes in the base carbon, by new flashing and treating apparatus, and by the employment of a new flashing method only capable of being utilized with the new material used and in very short lengths of filament in small flashing bottles of barely sufficient capacity for the reception of the filament. Compressed acetylene, the richest carbon gas known, is employed for the deposition of graphitic carbon upon the base. One of the first difficulties encountered was the lack of exact homogeneity and cross seection in any known incandescent lamp carbons, and while this feature was of secondary importance, when compared with the graver questions. involved in the combination of sustained brilliancy and long life, it could not be neglected. To obviate it the manufacturers were compelled to build an apparatus of extreme sensitiveness and delicacy, both mechanical and electrical, for the test of the raw "squirt" materials. They were also compelled to construct at considerable cost new forms of machinery for the production of these filaments. The apparatus which is now completed has a capacity of 40,000 filaments a day. It is entirely automatic in its character, and of the greatest precision. While the excellent qualities of these lamps can only be fully appreciated by continuous use, the mechanical advantages of a filament which will remain symmetrically in the centre of the bulb without the deleterious support of anchors or braces can be appreciated at a glance.

The manufacturers are to be congratulated upon having achieved success after a long and arduous period of experimentation, during which they were compelled to carefully examine many widely divergent fields before attaining the desired results.

A New Circuit Breaker.

A line of electromagnetic circuit breakers involving a new principle has just been put on the market by the Sentinel Electric Company, Wilmington, Del. Realizing the demand for an electromagnetic device to replace fuses, and appreciating the danger of substituting secondary break circuit breakers, especially in cases where constant inspection and attention are impracticable, the inventors of the Sentinel electric circuit breakers have succeeded in producing a device which is claimed to be absolutely reliable, positive in its action at all times, and which may in all cases replace fuses with satisfactory results, requiring only an annual inspection.

The various sizes of the type herewith described are adapted to the protection of circuits of from 6 to 200 amperes, alternating or direct current, at any

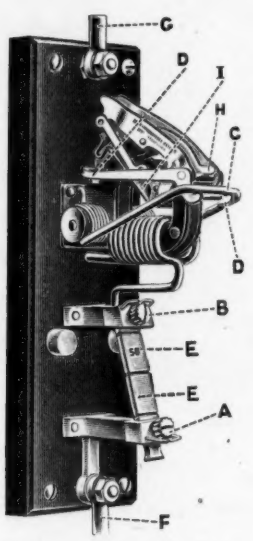


Fig. 1.—Breaker Set.

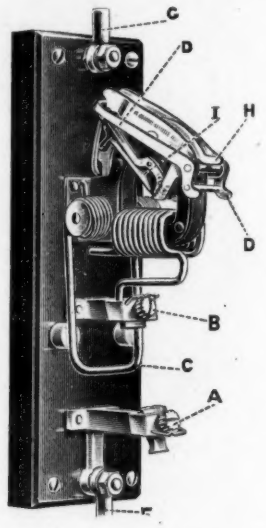


Fig. 2.—Breaker Discharged.

voltage up to 250, and are furnished in single pole, double pole or triple pole, with either front or back connections.

Referring to Figs. 1 and 2 the main terminals are at *F* and *G*, part of the circuit being composed of the metal bar, *E E*, which is made of a brittle, non-arcing alloy. Upon the discharge of the circuit breaker the spring *C* breaks out the sections *E E* of the bar, as shown in Fig. 2, thus insuring an absolute disruption of the circuit. When setting the circuit breaker, with the upper mechanism, *D D*, in the position shown in Fig. 2, the spring *C* is lifted until it raises the trigger *H*, when the lever *D* will fall and the spring *C* remain set. The screws *A* and *B* are then loosened, and a new bar is inserted and clamped securely by the screws.

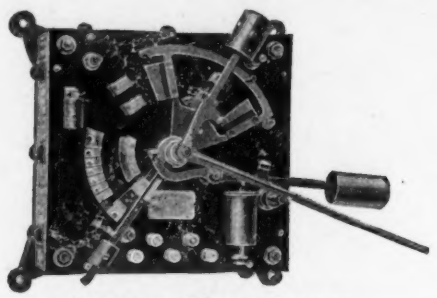
The following salient features are claimed and guaranteed for these circuit breakers: (1) The circuit once broken can never be closed by the same piece, and the necessary insertion of a new bar insures a perfect connection each time the device is recharged. (2) No moving part of the mechansim is connected with the circuit, and one charged it only requires an annual inspection, not being affected by changes of temperature or dampness. (3) The breakers are adapted to both alternating and direct current circuits, with a maximum efficiency and accuracy of calibration. Owing to the fact that they have no appreciable lag, fuses may be replaced with no increase in the total losses. (4) But few screws are used in the mechanism, and these are locked and cannot

be loosened by vibrations, neither will vibrations of any nature affect the "set" or discharging point of the breaker. (5) When employed as a protective device for light services it may be operated with perfect satisfaction without the aid of a switch in series with it to finally close the circuit after charging the breaker. In the event of an abnormal load of momentary duration, the breaker may be set and the circuit closed by the insertion of a new bar. When discharged by an abnormal load or short circuit of a more serious nature, the spring *C* may be set, and a new bar inserted until it touches the upper bar holder, when the spring *C* will be discharged and effectually break the circuit without any danger of injury to the operator.

The Sentinel Electric Company has also perfected a combined switch and circuit breaker, which is highly recommended for the protection of motors furnishing power for machine shops and factories.

Automatic Motor Starter.

We illustrate herewith a new and improved automatic motor starter just being introduced by Messrs. Zimdars & Hunt, 127 Fifth avenue, New York. In this device they believe that they have an article which is free from the many causes of trouble so common in apparatus of this class. It is operated entirely by gravity, no springs nor solenoids being employed. The various operations required to properly start a motor are accomplished by the force of a system of falling weights acting through the interaction of a number of levers. The time taken to effect a complete starting can be varied by making adjustments on the pivoted air dash pot, with screws provided for the purpose. This device is entirely automatic in its action, the rate of starting being beyond the control of the operator when once the operating lever has been thrown.



AUTOMATIC MOTOR STARTER.

A number of advantages claimed for this article are as follows: Double-pole, double-break main knife switch; knife form of rheostat contacts; absence of springs and solenoids; properly proportioned contact faces and current-carrying parts; improved form of pivoted air dash pot; automatic magnetic release; accurate adjustment in all parts; and absolute reliability in action.

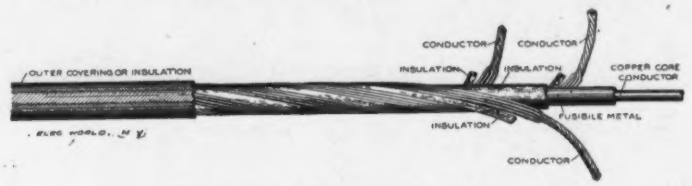
The device shows evidence of very careful designing, and this, supplemented by the high grade of workmanship employed, should recommend it to all persons desiring to start their motors from a distant point.

A New Interior Electric Cable.

Among the innumerable applications of the electric current none are worthy of greater consideration than those intended to save and protect the life and property by affording a means of proper communication in case of fire. Manual fire-alarm systems, in which a signal box is operated by persons who have discovered the conflagration, transmit their messages to suitable centres, from which the fire corps, equipped with the necessary fire fighting implements, are immediately dispatched to combat and conquer the flames. Such systems have become universal, and are largely augmented in their usefulness by automatic systems, which by means of thermostat devices located at certain points throughout the buildings, and connected by an electric circuit with suitable signal boxes, provide a never-sleeping watchman, whose faithfulness has been proven in many instances. Although the general principles involved in such systems are highly efficient, yet the method of application lacks one great feature, namely, that it is only practicable to locate the thermostat device at certain points. It would be almost entirely impossible from a practical standpoint to distribute sufficient automatic thermostats as ordinarily used to guarantee absolute protection from every possibility of an incipient fire. Fires frequently occur even in rooms where thermostat devices are located without affecting them until the conflagration has progressed to a serious extent. It is certainly possible to multiply these thermostat devices and locate them more frequently, but even then this deficiency would always exist unless a continuous line of thermostatic devices extended from one point to the other of the fire protecting circuit.

It will also be readily appreciated that such fire alarm systems have no other function but to serve as a fire protection system. They are solely installed for the purpose of fire protection, and are, consequently, a dead investment in instances where fires are but a rare occurrence. It is on this account that such systems are rarely installed in buildings where the fire risk is but slight, frequently to the disadvantage of the property to be protected.

The value of a system of wiring which could be used not only for fire protection but which would also be available for other purposes, such as bells, telephones and other signals, may be well considered as very great. It is not only with this object in view, but also particularly with a desire to afford an absolutely positive continuous system of thermostatic protection, that the new concentric thermostat cable is being introduced by the Montauk Multiphase Cable Company, of 100 Broadway, New York City. The cable consists of a central core of fusible wire, sometimes with a copper centre. Around this fusible wire is a wrapping of insulating material. With this insulated core may be any suitable number of bare conductors, all being inclosed in an exterior braid. The central core of fusible alloy wire melts at a low temperature, about 370 degrees Fahr. Any moderate fire, therefore, in the vicinity of the cable will easily generate sufficient heat to accomplish this. When the temperature in the vicinity of the cable has reached the melting point of the central core, the latter liquefies and by its expansion is immediately forced through the fibrous insulating covering, short circuiting any two or more of the conductors with which it is concentrically surrounded, and thereby transmitting the signal. Owing to the peculiar softness of the metal, a cutting or breaking of the cable will produce almost similar results. It therefore at once signals a mechanical injury. The fibrous winding of insulation around the alloy core is treated with certain compounds, and forms an excellent insulating covering around the core, although permitting the molten alloy to easily flow through and cross connect the outer wires. The outer wires are so wound that each is carefully insulated from the other, and they may be used for an automatic fire alarm



CONCENTRIC THERMOSTAT CABLE.

signal or another signal transmission purpose. A number of these wires are sometimes used so as to produce positive action and guard against uncertainty, and are conducted to the various testing instruments included in the system. Such cables containing from two to six conductors, in addition to the central core, are now being manufactured by this concern. It is not absolutely essential to use the outer wires for fire alarm purposes; they are equally available for telephone or telegraph use. The peculiar advantages resulting from the use of this combination electric cable will readily be appreciated when it is considered that, for instance, in wiring a building for bells, telephones, annunciators or any other similar purpose, this cable may be used with but slight additional expense, and not only run to and between the devices of the signal system, but also run throughout the various rooms that are to be protected from fire. The cable may be run anywhere, and, being inexpensive, its disposition need not be considered with such care as with individual thermostatic devices. A building wired in this fashion is consequently thoroughly protected with an automatic thermostatic fire alarm system, which does not form idle property, but is continuously being used for other purposes.

The Montauk Company has developed a number of electrical circuit arrangements for this continuous fire alarm cable, by means of which the concentric wires are used for various telephonic and telegraphic signals, and at the same time serve as fire alarm wires to be acted upon by the melting of the central core, as above described. A large field will undoubtedly be open to this new construction material, with its many economic and safety functions.

A Model Factory.

The tendency among large manufacturing concerns is to themselves manufacture all the detail parts that are used in the construction of their finished products, and not depend upon outside and independent sources of supply. The advantages of this policy are obvious. Such facilities enable the manufacturing company to control the production of the smaller parts with reference entirely to its own demands, and be free from the many annoyances that are liable to arise at any time where dependence must be placed upon an outside source of supply.

The Manhattan Electrical Supply Company, of New York, recognizing the advantages thus derived, has built up a factory that is about as complete an institution of this kind as can be found anywhere in the country. The company manufactures and deals in general electrical supplies and manufactures everything that is used in the construction of the varied lines of goods dealt in. Its factory is located on Morris Street, Jersey City, N. J., and runs through the block to Essex Street, the entire property being owned by the company. On the lots are several buildings, the main one being a substantial brick structure, 50 x 100 feet in dimensions, five stories high and a basement. There is another building of the same dimensions, but of one and a half stories in height. The buildings are lighted by electricity. They are wired for 500 lights, current being generated on the premises. The factory is run by steam power, which is distributed through the various floors by means of a vertical shaft running up from the engine room in the basement. Power is supplied by a 75-hp Hamilton-Corliss engine. In the basement, besides the engine room, are forges and a "former" for the shaping of magnets and everything that requires fashioning. There is also a powerful cutting machine.

On the first floor are manufactured speaking tubes and zinc cups for the "Mesco" dry battery. A portion of the space is utilized as a japanning room. An oven is also located on this floor. The oven is heated by steam to a temperature of 280 degrees. It has 600 square feet of steam radiating surface.

The second floor is a busy one. Here are located all the heavy machines, such as drills, lathes, automatic screw machines, etc. An interesting piece of mechanism is the automatic screw machine, into one end of which is fed a bar and at the other end the finished product is delivered. Two of these machines are kept running continuously, one making dry battery screw nuts and the other zinc pole pieces. The machine making the latter parts cuts the screw hole and the side holes, all in one operation. A punching machine on this floor punches out of zinc sheets the discs that are to form the bottom part of the zinc cups of dry batteries. On this floor are also the finishing and lacquering rooms, the polishing room and the electroplating rom. In the latter are baths of five different solutions.

The manufacture of telephones, medical apparatus, call-bell outfits, etc., is carried on on the third floor. There are various lathes and drills used in the manufacture and finishing of the various parts entering into the construction of the different apparatus made on this floor. Magnets are also wound here.

The work conducted on the fourth floor is of the same general character as that on the third floor. It is almost entirely bell work, including assembling, winding, etc., except the japanning, which is done on the first floor as already mentioned. On the fourth floor about 500 complete small bells are produced per day.

On the top or fifth floor, all the cabinet work is carried on. Here are made and finished in almost endless variety boxes and bases for telephones, medical batteries, telegraph instruments, etc. Great care is exercised in finishing and polishing the hardwood boxes.

The one-and-a-half story building above referred to is an interesting though grimy place. All the carbon work is conducted here, so it could hardly be expected that it can be kept as immaculate as the decks of a man-of-war. There are two carbon kilns, each with a capacity of 75,000 carbon plates. The ovens are 13 feet deep inside, and are fired with soft coal. On the first floor are the carbon crushers and pulverizers, which crush and grind the carbon lumps to pieces of graduating fineness, until finally an impalpable powder is produced. Carbon moulding is done in this same room, with hydraulic presses, which exert a pressure of 100 tons on the plastic raw material. The carbons are baked in the ovens for ten days, and kept there for over two weeks before they are taken out. In another room are the mixing machines, where carbon and pitch are mixed, prior to moulding. Elsewhere on this floor dry battery cells are assembled and finished. The wax used for sealing is heated by steam.

The Manhattan Company itself reduces the manganese and carbon used in the cells of its dry battery, and purchases zinc in sheets in carload lots. Everything that enters into the construction of the company's dry battery is manufactured on the premises from the raw material. The factory is heated throughout on the Webster steam heating system, which is giving the best of satisfaction. Good heat is obtained in the coldest of weather, not using all the exhaust steam.

The Manhattan Electrical Supply Company has taken the lease for the entire building at 32 Cortlandt Street, New York, where its offices are now located, and will, after May 1 next, make extensive improvements and enlarge its office facilities and the retail department.

Direct-Coupled and Belted Multipolar Generators.

The accompanying illustration represents the belted type of multipolar generator designed by Mr. Alfred A. Thresher, and built by the Thresher Electric Company, Dayton, Ohio. These multipolar machines are also made of the direct connected type for stationary and marine work. Every detail in the construction of all has been carefully studied. All parts are so proportioned that no adjustment of brushes is required from no load to 25 per cent. overload, there being, it is said, no sparkling over this range, no matter how sudden or great the change of load. Ample allowance has been made for the thorough ventilation of all parts, so that the temperature of armature or fields never rises to more than 75 degrees Fahr. above that of the surrounding atmosphere during a full day's run. In rating these generators allowance has been made for the great variation in load consequent upon certain classes of service, so that a 50 per cent. overload can be carried for a short time without difficulty.

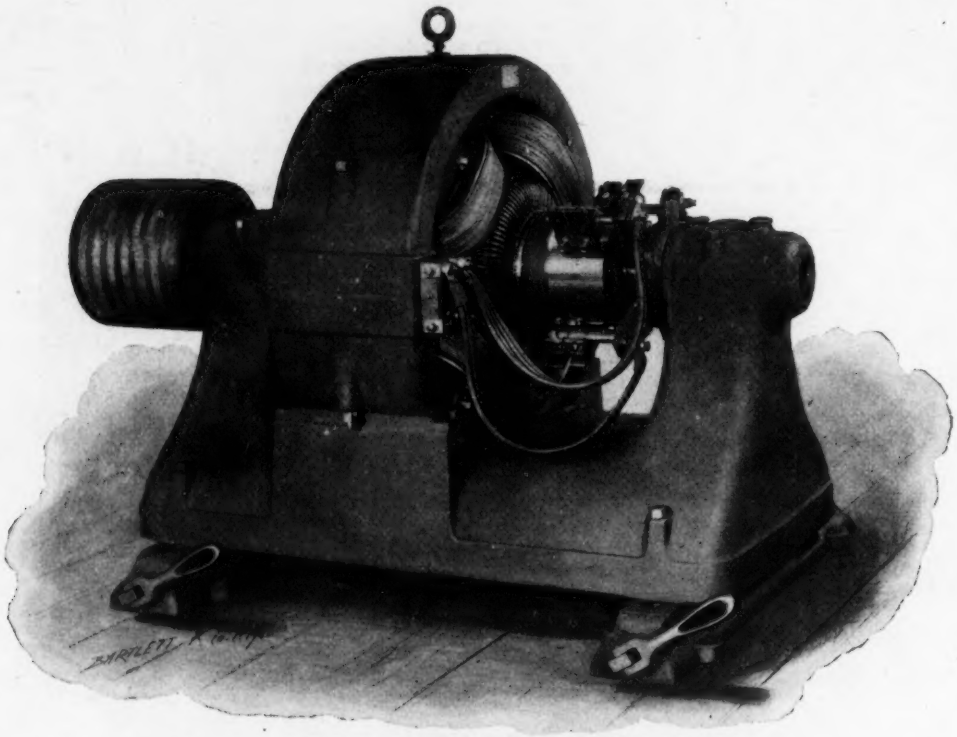
The field frame is of soft cast steel, supported on the extended sub-base of the engine, of sufficient cross section to carry the required magnetic flux. The field coils are wound on insulated forms and slipped over the polar projections, where they are held securely in place.

The armature is built upon a spider, and pressed on the shaft with hydraulic pressure. Ventilating spaces are provided of such number and capacity as to thoroughly ventilate the core throughout. The conductors are continuous copper bars, laid in slots in the armature core, and thoroughly insulated therefrom with mica insulation. They are so placed as to avoid bringing into near proximity bars differing greatly in potential, so as to obviate the danger of short circuit.

The commutator is built upon a separate bush, and mounted directly upon the spider of the armature, giving great rigidity and yet easy of access in case it becomes necessary to remove it. The bars are of hard-drawn copper, insulated with the best of East India mica, and held firmly in position by strong clamps, so that it is impossible for them to come loose. The brush holders are designed for the use of carbon brushes, allowing a contact surface of the brush on the commutator of 1 square inch for every thirty amperes of current to be carried at full load.

The out-board bearing, when furnished by the company, is of the universally supported, self-oiling type, having two oil rings feeding from a large reservoir and supplied with indicator to show the height of oil.

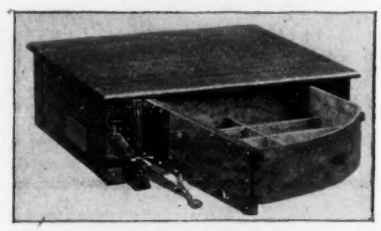
The smaller sizes of multipolar generators have been designed to be direct coupled to high-speed upright engines for marine and other plants, where small and compact units are required. These machines have met with the most marked success, and are recommended by some of the highest authorities among marine engineers. The belted types of multipolar generators in all essential details of design and construction are built upon the lines just described. They are distinctively slow speed. The base frame is strong and massive, the journal boxes being cast in one with the frame, giving great rigidity. The centre of gravity is very low, insuring smooth and even running. Sliding ways are provided with ample play to allow adjustment of belt.



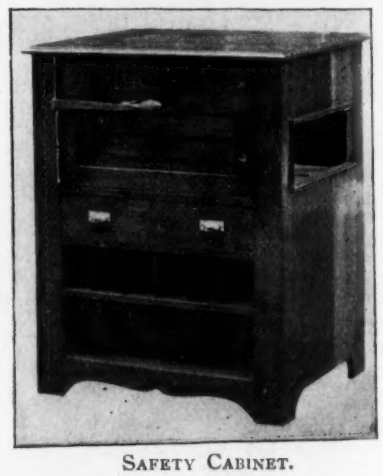
Belted Multipolar Generator.

Safety Cash Drawer.

The Cashiers' Electric Safety Cabinet Company, Cleveland, Ohio, during the past summer produced an iron safety cabinet for banks and business houses, and after placing it on the Western market found that not only banks, but small business houses, such as restaurants, drug stores and saloons required something of the same sort in their business, but cheaper and smaller. The Safety Cabinet Company at once proceeded to develop a cabinet that would meet this demand, with the result that the cash cabinet and drawer illustrated herewith were produced, and are giving satisfaction. The drawer and cabinet can be used as a regular cash drawer in the usual way, and give, it is stated, absolute security and prevent the possibility of daylight robbery by "hold-up" or by a sneak thief. This device can be placed in any position, and wires run to any point in the office, placing it under the control of every officer, bookkeeper, cashier or stenographer in case of a raid. It discounts carelessness, as the drawer cannot be left open or unlocked. Should a sneak thief or anyone not accustomed to using it undertake to open the drawer a gong will instantly sound an alarm as soon as the drawer is touched, and should there be any attempt to make a raid on the bank, the drawer can be instantly locked and an alarm given from any point in the bank or office by simply touching a button, either by the foot or hand. This permanently locks the drawer and starts the gong a-ringing, making it impossible for the cashier to open the drawer until the keys are brought from the outside.



Cabinet Cash Drawer.



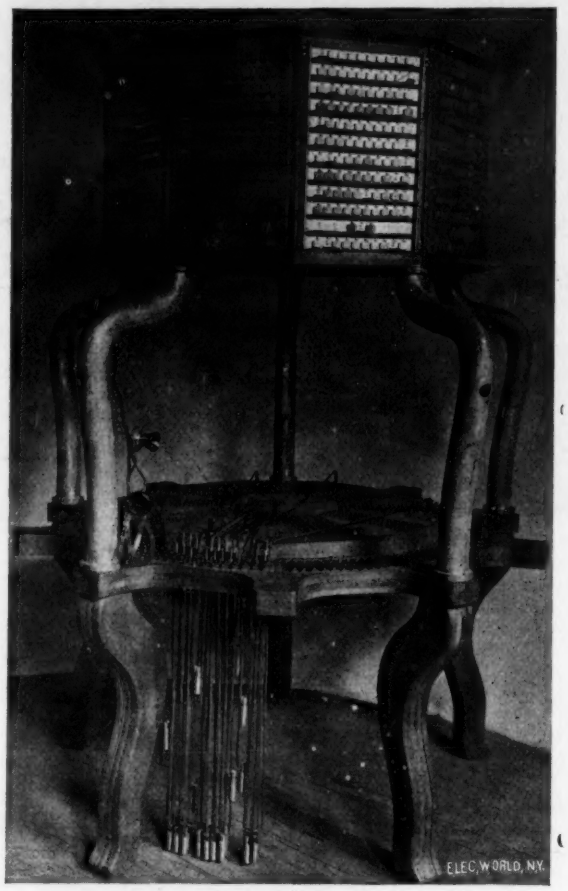
Safety Cabinet.

The drawers and cabinets are manufactured in a neat manner, and afford the utmost protection to the funds of any bank or business house. The manufacturing company guarantees the device to work perfectly. The batteries used for the purpose are also guaranteed. They are long lived, as they are very little drawn upon for current.

No doubt this safety drawer will meet with a very large and general demand on account of the increased protection it affords over anything of the sort that is available at the present time.

An Improved Telephone Switchboard.

Independent telephone managers and others concerned in this industry will be interested in the switchboard made by the Swarts Switchboard & Electric Company, Knoxville, Tenn., an illustration of which is shown herewith. This board presents a radical departure from prevailing designs, and is said to meet the need of independent telephone exchanges for a convenient switchboard. By its use the necessity of connecting lines between sections is dispensed with,



SWITCHBOARD FOR INDEPENDENT EXCHANGES.

each operator making direct connections to any of 1000 lines. The drops are restored by the company's rapid restoring device. In construction the board is simple. In practical use it requires only one move on the part of the operator to answer a call; two to connect, and then the entire operation is completed by pressing the ringing key. The People's Telephone & Telegraph Company, Knoxville, Tenn., one of the largest independent companies in the South, is using a Swarts board which is said to be giving satisfaction.

Improved Indicator.

The improved Robertson-Thompson indicator, which has just been placed on the market by Messrs. James L. Robertson & Sons, 204 Fulton Street, New York, is unusually heavy, but this weight is so perfectly distributed that the best results may be attained at speeds far in excess of any met with in actual practice. One of the most serious errors in ordinary indicator work is caused by flexure of the arm which carries the drum, particularly when the cord is carried above or below the instrument. In this manner an error of 10 per cent. is possible, particularly if the instrument is being used with a high-pressure

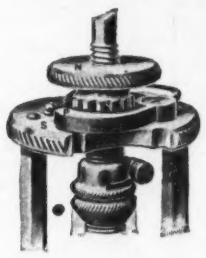


FIG. 1.

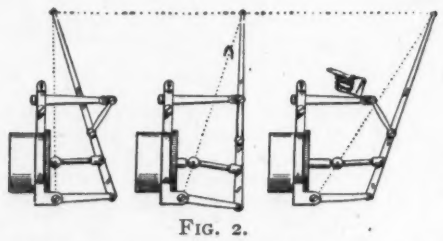


FIG. 2.

spring. The drum carrying arm of the improved Robertson-Thompson indicator is so stiff that no error from this cause is possible.

The cylinder is steam jacketed, and by its construction the possibility of the piston being cramped, as a result of external strains, is precluded. The area of the cylinder is exactly one-half inch, and each spring is suitable for twice the pressure stamped on it. The coupling is reamed to one-quarter inch area, and with each instrument an extra one-quarter inch piston is furnished. With this piston each spring may be used for pressure four times as great as the number stamped thereon, so that with a sixty spring 240 pounds may be safely indicated. This extra piston is of special value for hydraulic and gas engine work. The pistons are made of steel, but phosphor-bronze will be substituted if preferred. The piston springs are standardized by the most approved testing apparatus, in connection with the mercury column. To guarantee against pressure above the piston a large relief opening has been provided, the outlet being a neat swivel elbow, by means of which the "blow" may be discharged in any direction, at the will of the operator. Each instrument is provided with a detent or stop motion.

In Fig. 1 a new device is shown for adjusting the tension of the drum spring. By rotating the knurled head, *S*, to the right, the spring may be tightened as much as desired and securely held by pawl *P*; the ratchet wheel, *N*, is securely attached to the shaft by means of a left-hand thread. Thus the tendency of the drum spring is to tighten this ratchet out more firmly. By pressing the thumb into the recess in the spring winder, *S*, the pawl is released, when the tension may be diminished to any desired amount. This ratchet wheel has sixteen teeth, which provide for the adjustment of the spring to a nicety. Drum springs are of the clock type, but spiral form will be furnished if preferred. Cone bearings are provided to take up all wear of the drum spindle. The parallel movement is made of tool steel, highly polished and richly blued. All bearings are wide and perfectly fitted.

In Fig. 2 the pencil mechanism is shown in three positions, which will give a perfect idea of the manner in which an absolutely correct straight line is obtained. This movement forms a perfect pantograph, so that the pencil movement is exactly proportional to that of the piston, the ratio being 5 to 1. All moving parts are worked down to the lightest weight.

Automatic Time Cut-Off.

The advantages in using the automatic time switch are well recognized. It is particularly valuable in reducing the average electric light bill by promptly switching off the current at a predetermined time.

Many devices of this kind have been placed upon the market, but Messrs. J. Jones & Son, 67 Cortlandt Street, New York, recognizing a demand for an instrument of low price and reliable in operation produced the apparatus illustrated herewith.

The mechanism is simple. It consists of a standard 35-ampere fused, all-copper switch, suitably mounted so that it can be wired from the back or front, together with a one-day clock, all mounted upon a black enamelled slate base, ready to screw to the wall. The clock mechanism releases, at the predetermined time, a weight, which, in falling, opens the switch and circuit. The instrument is recommended by the manufacturer as reliable in operation. It can be kept under lock and key if desired. In its production the firm had three objects in view, viz.: Simplicity and accuracy in operation, mechanical strength and electrical capacity and low price, and all of these it claims to have succeeded in accomplishing.

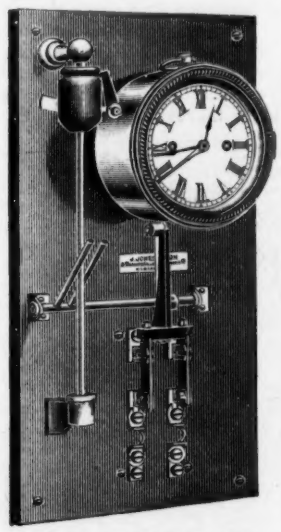


FIG. 1.—SWITCH CLOSED.

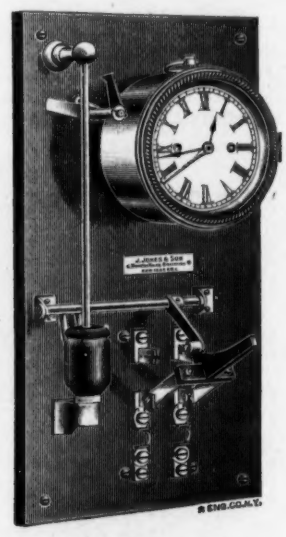


FIG. 2.—SWITCH OPEN.

Fig. 1 shows the switch closed and the weight in position ready to be released by the clock. In Fig. 2 the switch is shown opened by the fall of the released weight.

New Belt-Driven Railway Generator.

So rapid has been the development of the railway generator directly connected to the driving engine, and so extensive its adoption, that the railway public is liable to lose sight of the fact that the belt-driven generator is still greatly in demand. Many cases exist in which the conditions do not warrant the installation of direct connected apparatus, and to these cases the belt-driven generator is more applicable.

The distinguishing features of the General Electric Company's direct connected apparatus have been incorporated in its new line of belted machines. These are all six-pole generators, built in five sizes, ranging from 110 kilowatts to 500 kilowatts. That shown in the illustration is a 110-kw, six-pole, 500-revolution machine.

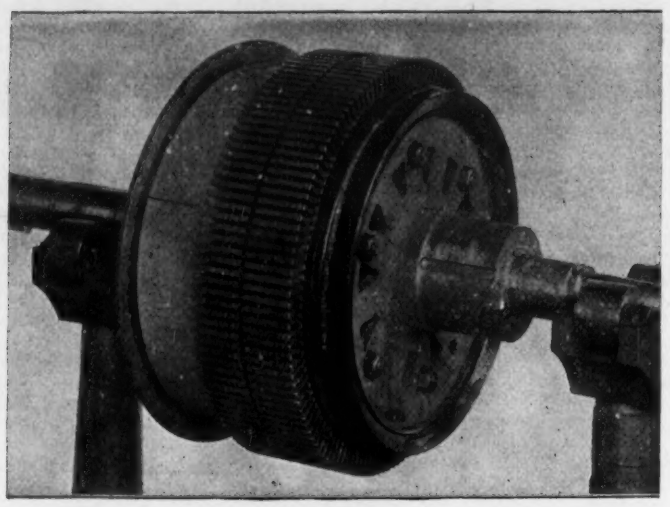
The magnet frame is of cast steel heavily ribbed, making it both light and compact. Its magnetic efficiency is the highest obtainable. The bearings are built upon the ball-and-socket principle, are self-aligning and self-oiling. The armature shaft has been increased in size, and the bearings lengthened, two features substantially guaranteeing cool operation. The steel poles and pole

pieces are cast in one piece, and so bolted to the frame that they may be easily removed without disturbing either the armature or the frame.

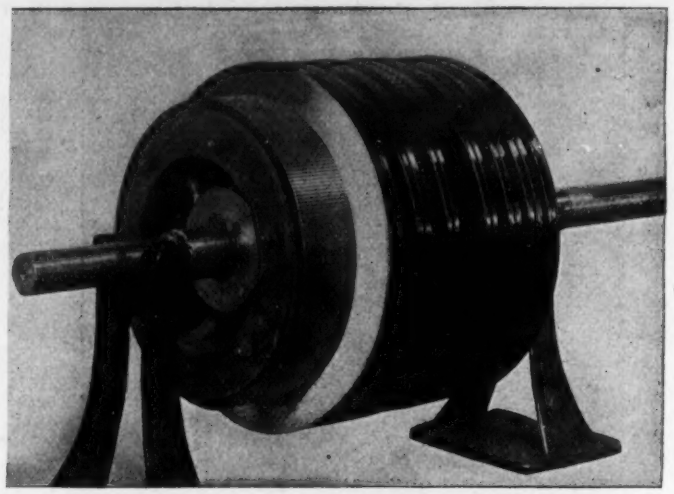
The series winding of the field coils is of flat copper ribbon, the shunt winding of wire. Instead of winding the series coil on the field spool and covering it with the shunt winding, both windings are placed side by side on the pole, and, being entirely independent, either may be removed without disturbing the other.

The armature is of the barrel-wound type, such as is used in the General Electric direct connected generators. The cast-iron flange, bolted to the armature spider at each end of the core, forms a support as well as a cylindrical receptacle for the projecting ends of the coils. The coils are secured firmly in the slots of the core, and the cross connections are made on the barrel flange. The projecting ends of the coils in the flange are thoroughly insulated and held in place by steel bands. Ventilation is effected by the use of specially constructed vanes, forming air ducts between the laminæ of the core. These convert the armature into a blower, and create a strong draft through the windings. The commutator leads are taken directly from the coil to the segment immediately beneath it. The construction of the commutator is similar to that of the direct connected machine. It is ventilated by air drawn through the body and discharged through air ducts in the core. The small difference of potential between the segments secures the permanence of the insulation and freedom from sparking.

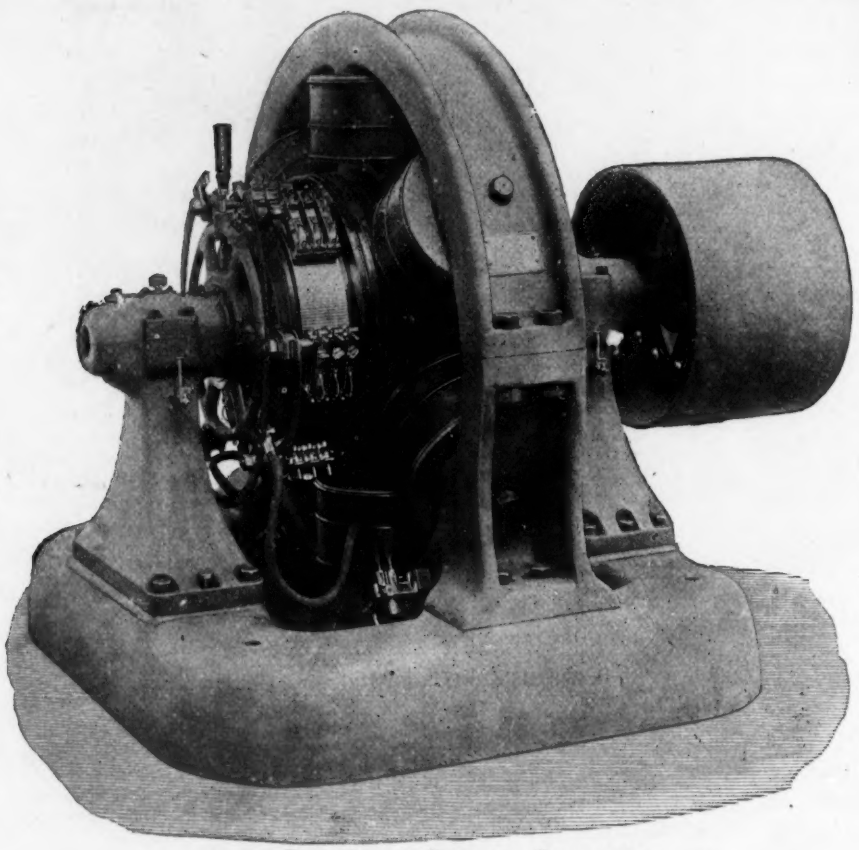
The strength of the magnetic field in these generators is so proportioned to the armature reaction that a constant brush lead and neutral point are insured being practically non-existent.



Armature Core for Railway Generator.



Armature Core with Commutator Complete.



110-kw Belt-Driven Railway Generator.

Enclosed Arc Alternating Current Lamp.

The illustration shown below is of the indoor type of the enclosed arc alternating current lamp manufactured by the Standard Thermometer & Electric Company, Peabody, Mass. The lamp is very simple in construction, burns steadily and without noise. It makes a very handsome appearance, and the cover can be finished in any color desired.

On 16,000 frequencies the lamp operates direct on secondary circuit of from 100 to 125 volts without transformer or resistance. Where the lamp is desired to operate on 7200 frequencies, an induction coil is provided and placed in the cover. The maker guarantees for this new improved lamp a life of at least 120 hours with one set of carbons, at an average current consumption of from 360 to 400 watts. With clear globes a nominal candle power of 1000 to 1200 is obtained.

The mechanism of the lamp is so held in the cover as to confine the vibrations, preventing the escape of noise, either from the arc or metallic parts. The clutch of the lamp is provided with a spring, which prevents the carbons from slipping. The trimming device and inner globes as well as outer globes are the same on this new type of lamp as on the improved enclosed arc lamps of all other types made by this company. For outdoor service the lamp is provided with a hood and arm, so that it is shipped from the factory all ready for installation.

These lamps are giving very satisfactory results in practical operation, all noise, which formed so disagreeable a feature of earlier alternating arc lamps, being practically nonexistent.

Enclosed Arc Alternating Current Lamp.

News of the Week

Financial Intelligence.

The stockholders of the Boston Elevated Railway Company on December 18, in response to the call of the directors, paid in on the capital stock of the company 47 per cent. of the par value, which, with the amount already paid in on said stock, amounts to $5,000,000, the sum necessary to carry into effect the provisions of the West End lease. At meetings of the directors of both companies, held on December 20, the transfer of the assets and franchises of the West End Railway Company was authorized.

THE MEXICAN TELEGRAPH COMPANY has declared a quarterly dividend of 2½ per cent., payable January 13.

THE CENTRAL SOUTH AMERICAN TELEGRAPH COMPANY has declared a quarterly dividend of 1½ per cent, payable January 6.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Dec. 27, 1897.

THE GOODYEAR VULCANITE COMPANY has moved its headquarters from 353 to 568-574 Broadway.

THE AMERICAN STOKER COMPANY, Dayton, Ohio, announces the removal of its offices from that city to Brooklyn, N. Y., where it is located in Rooms 72-74, Garfield Building.

THE STATE RAILROAD COMMISSION has granted permission to the Metropolitan Street Railway Company to adopt the underground trolley system on that portion of its system running on Thirty-fourth Street, between Second Avenue and the Long Island Ferry. Permission was also granted to the Second Avenue Railroad Company to adopt the underground trolley system on that portion of its line on Ninty-sixth Street, between First and Second Avenues.

AT THE INTERNATION HEALTH EXPOSITION, which will be held at the Grand Central Palace, in this city, from April 25 to May 31 next, there will be some features of general interest to electrical people. According to a circular sent out by the officials of the exposition, Mr. Nikola Tesla will make a personal exhibit, and will show for the first time some novel apparatus, designed for the cure of certain diseases. He will also communicate his views as to some of the possibilities of electricity in the prevention of disease and the prolongation of human life. Mr. Luther Stieringer has been retained by the Exposition Company as its consulting electrical engineer. Mr. B. E. Greene is secretary of the exposition.

CAPT. W. WOLCOTT MARKS, superintendent of the Bishop Gutta Percha Company, New York, received as a Christmas present a handsomely engrossed set of resolutions appropriately framed, presented by his assistants, through whose combined interests the first gutta percha insulated and copper armored cable was constructed. This memento is to commemorate the successful laying by Captain Marks of this submarine cable on May 8, 1895, in Gedney's Channel, since which time the main entrance to the Port of New York has been electrically lighted.

A PETITION addressed to the Commissioner of Public Buildings, Lighting and Supplies (under whose jurisdiction the new charter places the Bureau of Electrical Appliances) is being circulated in the electrical trades for signatures, favoring the retention of Mr. Alexander Henderson as the head of the new bureau. Mr. Henderson has been in charge of the electrical bureau at the Fire Department headquarters. It is stated that the signers of the petition up to the present time represent an investment of nearly $200,000,000 in electric lighting and power plants in this city. Some well known and influential names, we are informed, are subscribed.

ACETYLENE EXPLOSION.—On Friday morning, December 24, the works of the United States Acetylene Company in Jersey City, were destroyed by fire, accompanied by a series of explosions which did great damage in the neighborhood, and resulted in the death of two men and the injury of others. The fire started apparently with an explosion, followed by ten or twelve more as the different tanks and retorts were reached by the flames. The first explosion was alleged to have been due to the most prevalent cause of all gas explosions, namely, the leakage of the gas forming an explosive mixture with air in an enclosed room, accidentally lighted in some unknown manner.

THE POSTAL TELEGRAPH COMPANY CHANGES ITS WIRE GAUGE.—Beginning January 1 the Postal Telegraph-Cable Company will change the nominal gauge numbers of its galvanized iron wires from B. W. G. to Brown & Sharpe gauge, changing the present No. 6 to No. 4, the present No. 8 to No. 6, and the present No. 9 to No. 7, and in the future if any iron wire should be ordered it will be ordered according to the Brown & Sharpe gauge numbers for the purpose of bringing about as far as possible a harmony between the gauges of iron and copper wires. The electrical engineer of the Postal Company, Mr. F. W. Jones, considers it desirable that all other large users of wire should join in this innovation, as it will be more agreeable to the large manufacturers and be a great step toward simplifying the gauge muddle, which the lapse of time is making worse. While Mr. Jones has no prejudice against the decimal system, he is quite pronounced in his disapproval of the habit of some electrical engineers, particularly those attached to colleges, in publishing their calculations and results in metres, grammes, centigrade units, whereas there is no large practical concern in the country that uses such units, and consequently the value of such publications is greatly impaired by being practically in a foreign language. This country universally, in its everyday work and records, he adds, uses feet, pounds, inches and Fahrenheit units, and it is entirely useless for the school men to endeavor to force the use of the French decimal system until all parties are ready to start in all together. Mr. Jones also deprecates the use of several kinds of ohms. The international ohm being the latest, should, he considers, be the standard, but as a matter of fact there are not two large companies that have Wheatstone bridges whose ohms will agree with the standard ohm at a given temperature. The Postal Company's standard temperature for submarine cables is 75 degrees Fah., and that for land and office wires 60 degrees Fah.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Build'ng, 620 Atlantic Ave.,
BOSTON, Mass., Dec. 24, 1897.

THE HOPE ELECTRIC APPLIANCE COMPANY, Providence, R. I., has found it necessary to increase its capital stock from $60,000 to $100,000 to keep pace with the demand for its well-known switches and other specialties. The company will shortly remove from its present quarters in order to secure larger accommodations and better facilities for filling promptly its rapidly increasing number of orders. President Robert Fessenden, Secretary John I. Drake and Treasurer William Ely have the congratulations of all their friends on this satisfactory condition of affairs.

THE STANDARD THERMOMETER & ELECTRIC COMPANY, of Peabody, Mass., reports a good business in its various types of inclosed arc lamps. Among recent sales are fifty of its high tension series inclosed arc lamps, 6.8 amperes, for lighting the streets of Berlin, N. H., the purchasers of which have expressed themselves as being very highly pleased with the working of the lamps. Many other stations throughout the country are installing this type of lamp for commercial lighting, buying in quantities varying from five to fifty. The "Midget" 110-volt and two in series for 220 lamps are meeting with especial favor for mill and factory work, many large orders having been booked during the past two months. Reports from the various agencies of this company show that its recently improved lamps are meeting with appreciation. Although its inclosed arc alternating lamps have only recently been placed on the market, sales are being made in good shape and orders increasing constantly.

MR. L. I. FLETCHER, manufacturers' agent, 620 Atlantic Avenue, Boston, has organized his business into a company to be known as the L. I. Fletcher Company, of which Mr. Fletcher is president and Mr. George E. Grant, secretary. Mr. Fletcher has been successful in the manufacturers' agency line, sustaining his reputation as a "hustler." He has had from the start the agency of the Belknap Motor Company, of Portland, Me., and has made a fine record in sales of the Belknap motors, dynamos and Chapman voltage regulators. He has recently added to his agency the line of instantaneous "make and break" safety knife switches and other specialties of the Hope Electric Appliance Company, of Providence, R. I. Other specialties are being added, and it is Mr. Fletcher's intention to represent a full line of all necessary adjuncts for central stations, isolated plants, etc. Mr. Fletcher has identified with him an active and wideawake corps of bright salesmen possessed of just the same "get there" qualities which he possesses. He has also connected with his company a competent electrical and mechanical engineer in order that installations may be properly looked after. Mr. Fletcher is an old central station man, and his practical training in and knowledge of the electrical business enables him to abundantly satisfy and even anticipate the needs of customers.

PHILADELPHIA NOTES.

Branch Office of THE ELECTRICAL WORLD,
929 Chestnut Street,
PHILADELPHIA, Pa., Dec. 24, 1897.

MESSRS.. SMETHURST & ALLEN, electrical engineers and contractors, of this city, have moved their office from the Betz Building to 1222-23 Stephen Girard Building.

THE CHAMBERSBURG ENGINEERING COMPANY has been organized at Chambersburg, Pa., to carry on the business formerly conducted at that place under the style of the Taylor Engine Company.

CHANGE OF NAME.—The Lucent Refining Company, 212 South Third Street, this city, has changed its firm name to Union Petroleum Company. The company is thoroughly equipped for the manufacture of lubricating and illuminating oils, and has a full stock of these on hand ready for prompt shipment.

AN ILLUSTRIOUS SIGNATURE is appended to a letter in the possession of Messrs. Queen & Co. In it the writer thanks the firm for the X-ray tube sent him, and he takes occasion to make some complimentary remarks about it. The tube pleased him so much that he was constrained to ask the price at which they could be furnished in quantities. The person in question is Prof. W. C. Röntgen, of the Wurzburg University.

GAS ENGINES FOR ELECTRIC LIGHTING. The engines of the Otto Gas Engine Works, of this city, are evidently growing in favor as power generators in electric lighting. The company has just installed two 120-hp engines for operating electric light dynamos at Sisterville, W. Va, and two 50-hp engines at Mannington, W. Va., for the same purpose. The company states that the demand for its engine is good.

THE PRISMATIC ELECTRIC SIGN COMPANY, Williamsport, Pa., seems to be making good progress in enlisting public favor in behalf of its signs. Philadelphians are being entertained by means of some of these signs placed on some of our downtown business establishments. The changing colors of the letters are, to say the least, very attractive. The Philadelphia agency has been placed in the hands of Messrs. Eugene D. Hays & Co., 1215 Filbert Street. But the company's business is by no means confined to Philadelphia and vicinity alone. It has orders from Detroit, Mich.; Brantford, Ont.; New Orleans, La.; Redlands, Cal.; Newark, N. J.; Albany, N. Y.; Helena, Ark., and many other places. These signs can be made in any size.

Southern Notes.

WASHINGTON, D C., Dec. 24, 1897.

THE DENISON & CHOCTAW TELEPHONE COMPANY has extended its line from Eufaula to San Bois in the Choctaw nation. Other extensions are contemplated, and in a short time the company expects to have the system in operation all over the Choctaw nation.

THE BELL TELEPHONE COMPANY, it is stated, will renew its application to the Town Council of Hampton, Va., to establish an exchange in that place. The company has been twice refused permission to enter Hampton, but it is stated that public opinion has undergone a change since the last refusal.

TELEPHONIC COMMUNICATION will be established soon between Florence, Ala., and Leighton. The Southern Bell Telephone Company also contemplates building a line from Florence to Cherokee and Riverton, which will be put into operation some time during the winter. The company is also figuring on extending the line so as to take in Waterloo and Russellville.

THE RECENT STORM played havoc with the lines of the Home Telephone Company at Mobile, Ala. Poles were blown down in all parts of the city, and the wires became crossed with electric light wires. The switchboard in the exchange began to smoke, but the manager, by cutting all the wires at the tower, succeeded in saving the exchange from destruction. Two 100-wire cables were, however, burned out.

Buffalo and Niagara Falls Notes.

BUFFALO, N. Y., Dec. 24, 1897.

THE NIAGARA POWER PEOPLE have come down to something like exact figures in regard to the power to be sold in Buffalo. Mr. C. R. Huntley, vice-president and general manager of the Cataract Power & Conduit Company, which controls the distribution of the power in Buffalo, has advertised that an unlimited amount of power is now on sale. President Urban, of the company, says that he is able to promise a saving of from 30 to 50 per cent. of the cost of steam power. He will not, however, say just what the rates are to be. They will not be exactly uniform, as it will make a difference whether a consumer needs the power a few hours a day or the entire twenty-four. The acceptance of this offer by the city manufacturers and users of power generally will depend much at first on the condition of their steam plants and the cost of making the change. This will also be hard to estimate, and will vary greatly in individual cases, but it is at least pretty certain that there will be no more steam plants erected in Buffalo unless the electric power proves much less practicable than it now promises to be. There is now about 2500 horse-power in use here—1000 by the street railway, 1000 by the Northern elevator, 400 by the electric elevator and 100 by the Union dry dock. The street railway will soon take another 1000, and the Urban flour mill is putting in motors for 400, though it is quite doubtful if the streets can now be opened for the laying of conduits. In case a mill or factory is adjacent to the transmission line it can be supplied, though in Black Rock District little can be done till a transformer station is established, as it is not practical to deliver the current at 11,000 volts just as it comes from the line. The great advantage to be derived is by such concerns as the two elevators, which have no steam power whatever and no expensive shafting. The General Electric Company, of Buffalo, which has the lighting contract, has so far declined to accept Niagara power till some provision is made for bridging over accidents. It is true that the transmission line has been in operation a year without a break, either in the pole section or in the subways, but an independent line is needed to insure safety. This will in time be built.

Pittsburg Notes.

PITTSBURG, Pa., Dec. 24, 1897.

DIVIDENDS DECLARED.—The directors of the Union Switch & Signal Company have declared a dividend of 1½ per cent. on the preferred stock of the company, payable January 15, 1898. The transfer books will be closed January 5 to 15, both inclusive. The Westinghouse Electric & Manufacturing Company has declared a dividend of 1¾ per cent. on its preferred stock, payable January 3, 1898.

ELECTRIC LIGHTING PLANT FOR THE POST OFFICE.—A dispatch from Washington states that the appropriation for contingent expenses of public buildings will permit the installation of an electric lighting plant in the Government building at Pittsburg, at an expense of $25,000. Arrangements for doing this will be started immediately after January 1, when a man will be sent here to look over the ground and draw up the necessary plans and specifications.

THE PENNSYLVANIA CAR WHEEL COMPANY has been organized in Pittsburg, Pa., to manufacture car wheels for steam and electric service. The company will make a specialty of high-grade, chilled-iron wheels. It has abundant capital and a fine location.,Mr. Charles V. Slocum is secretary and treasurer. He and his brother, A. W. Slocum, who is also interested in the new enterprise, were for many years with the New York Car Wheel Works, of Buffalo, N. Y.

A DIRECT TROLLEY LINE TO THE M'DONALD OIL FIELD.—Application has been made for a charter for the Carnegie, Oakdale & McDonlad Street Railway Company, with a capital stock of $60,000. Mr. Wiilliam J. Steen, of Oakridge, Pa., is president, and the directors are W. J. McCully, Thomas Cooper, H. C. Johnson, J. M. Borden and H. M. Barber. The road proposed will extend from the terminus of the West End line, at Carnegie, to McDonald, running parallel with the Pittsburg, Chartiers & Youghiougheny Railroad. The run from Pittsburg to McDonald by this route will be about 20 miles long.

MR. SCOTT'S PAPER AT THE ENGINEERS' SOCIETY.—At the regular monthly meeting of the Engineers' Society of Western Pennslyvania, held on December 21, Mr. Charles F. Scott, of the Westinghouse Electric & Manufacturing Company, read a very interesting paper entitled "Alternating Currents —Some Recent Advances." After briefly sketching the development of the alternating current, and pointing out its advantages for long distance power transmission, Mr. Scott described in detail the modern methods of construction in dynamo building, and gave an account of the various types of alternating current generators and motors, describing their characteristics and showing the purposes for which each is best adapted. This part of the lecture was illustrated by means of numerous core plates, lathe wound armature coils, insulated armature bars, etc., which were exhibited and described by Mr. Scott. Among the large machines described were the Niagara generators, the 5000-hp generators that are being made for the St. Lawrence Construction Company and the 1500-kw machines built for the Allegheny County Light Company. An account was then given of the transmission plant at Hartford, Conn., and an interesting diagram was exhibited, showing in a very clear way the relations between the elements of this plant. Some time was then given to the Niagara plant, and a diagram was exhibited presenting in a striking way the method of generating and distributing the electrical energy at the great power plant, and all the various ways in which the power is utilized. Profusely illustrated printed copies of the paper were distributed to the audience before the lecture, and many references to the cuts were made during the reading. In the discussion which followed, Mr. Scott was called upon to answer many questions from the members of the society, and did it with his usual clearness.. His method of transforming three-phase current into two phase, and vice versa, was thoroughly explained, and some interesting points on the running of alternators in parallel were brought out.

Chicago Notes.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, Ill., Dec. 24, 1897.

THE WESTERN ELECTRIC COMPANY has secured permission to build a large addition to its manufacturing plant at 37-45 West Congress Street. The new structure will be of brick, six stories in height and will cost $80,000.

THE M. C. BULLOCK MANUFACTURING COMPANY, Chicago, has lately installed several central valve engines, direct coupled to Western Electric 125-light arc machines. Two of these sets were for the Municipal Lighting Commission of Detroit. The engines are triple expansion, with a water rate close to 13 pounds. The arc machines also have an unusually high efficiency, and under the excellent management of Mr. Steele a new record for economy may be looked for as soon as he gets these sets loaded up with their full number of lights. One of the first central valve, direct coupled arc lighting sets was installed at Brainerd, Ill., a little more than two years ago. The engines are compound, non-condensing, direct coupled to Brush dynamos. The cost per lamp is said to be far less than that at a second station owned by the same company, using the same type of dynamo, belted to compound Corliss engines, to say nothing of economy of floor space. The same company is just shipping the fourth engine to the Nichols Chemical Company, of New York. It is of 200 horse-power, triple expansion, condensing, to use less than 13 pounds of steam per I. H. P. hour, and to run for periods of thirty to ninety days without once closing the throttle. The company reports considerable other business on hand, some on order and part nearly ready for delivery.

Milwaukee Notes.

MILWAUKEE, Wis., Dec. 23, 1897.

THE STREET CAR COMPANY at Sheboygan, Wis., laid off its conductors, and this so increased the motormen's labors that complaints were made to the officials. Little attention was given to the appeals, but later an appeal was made so vigorously that an attempt will be made to remedy the difficulty.

ON ACCOUNT of the city agitating the question of a municipal lighting plant the Milwaukee Electric Railway & Light Company has offered its lights at a cheaper rate. The city is now paying $109 a year for lamps fed by underground wires, and $92 for overhead wired lights. The new offer places the rate at $93.50 per lamp year, regardless of the manner the wires are brought to the lamp.

LAST SUMMER LIGHTNING entered the store of John Baylieu at Viroqua, Wis., on the wires of the La Crosse & Southeastern Telephone Company, and destroyed the building and contents, valued at $1,900. Suit for damages was

brought, and verdict rendered for the plaintiff. A new trial was granted, which ended in favor of the defendant. The jury held that the company was not responsible for the loss.

ST. LOUIS NOTES.

ST. LOUIS, Mo., Dec. 22, 1897.

IT IS REPORTED that the Missouri Telephone Manufacturing Company, of St. Louis, has recently taken a large order for the equipment of an exchange in South America.

MR. J. C. HUBINGER, of Keokuk, Ia., and several Quincy capitalists propose to build an electric railway from St. Louis through Calhoun County to Quincy, in the State of Illinois.

THE BELL TELEPHONE COMPANY has secured a temporary injunction against the Belleville, St. Louis & Suburban Electric Railroad, restraining the road from interfering with the poles of the telephone company, which are located along the outside edge of the Turnpike road.

IN ALL PROBABILITY the Imperial Electric Light and Power Company will be among the bidders for the new public lighting contract, as the officials have succeeded in obtaining a permit to increase its duct facilities at the power house on Ninth and St. Charles Streets. The permission was obtained after a long controversy.

THE CITY COUNCIL of Belleville last Monday night gave the Downing Telephone Company a twenty-five-year franchise to construct and operate a telephone system in Belleville. It must be completed and connected with the Kinloch system in St. Louis within one year, and with the neighboring towns in two years.

THE STOCKHOLDERS AND BOARD OF DIRECTORS of the St. Louis & Belleville Electric Railway Company have passed a resolution to increase the capital stock to $500,000. It is also rumored that the road is backed and partially controlled by the Terminal Railroad Association, which owns and controls the lines in East St. Louis.

TURNPIKE ELECTRIC RAILWAY TROUBLES.—The Circuit Court of Belleville denied the application made to it for an injunction against the St. Clair County Turnpike Company and the Belleville, St. Louis and Suburban Electric Railway Company, restraining them from doing any more work on the new Belleville & East St. Louis electric car line.

MR. L. M. RUMSEY, the plaintiff in the case of Rumsey against the Peoples Railway Company, presented a petition this week, asking for the removal of Charles Green as receiver of the railroad. The plaintiff relates that Mr. Green, while former president of the railroad company, withdrew from the office a short time before he was appointed receiver, and caused his son to be made president of the company. He makes numerous other charges.

THE SOUTHERN ELECTRIC SUPPLY COMPANY has sent out notices to persons operating electric light plants in their places of business of an increase in the price of porcelain goods. This does not mean the forming of a trust or combine, but that prices have only been restored to the original schedule in force some years ago by agreement between the manufacturers in the East. The agreement simply affects the selling prices, and in no way restricts output. The advance ranges from 50 to 60 per cent. on the recent prevailing quotations, and places all dealers in electrical supplies on the same footing to work up trade.

TEXAS NOTES.

SAN ANTONIO, Texas, Dec. 21, 1897.

THE ENTIRE NORTHERN AND CENTRAL PORTIONS of Texas have been swept by a terrific sleet storm during the past four days. The telegraphic service throughout the State was greatly impaired, and it is estimated that the damage to telegraph property, in the breakage of wires and interrupted service, will reach the sum of $300,000. It is by far the worst storm that has ever visited Texas.

ANOTHER INTERESTING AND HIGHLY IMPORTANT DECISION in a telegraph case has just been made by the Court of Civil Appeals at Galveston. A telegram was sent from New Orleans by one Miss Burgess to Beaumont, Tex., and the grounds for damages were that by reason of its nondelivery the sender was detained for ten days in New Orleans without money or place to stay, and suffered great distress and anguish of mind. Fifteen witnesses were introduced, who testified that they knew the address of the person to whom the telegram was sent, and had they been asked they could have directed the messenger where to find him. The Western Union Telegraph Company defended itself on the ground that the message blank upon which the message was written contained the stipulation that unless claims for damages were filed within sixty days no suit could be maintained, and that the defendant company, through its messenger and agent, having asked as many persons or nearly so, as were not asked, where the addresses could be found, that it had used reasonable diligence. The plaintiff replied that the sixty days stipulation had no application because the laws of Texas made void any stipulation in the nature of limitation of less than ninety days, and further, that it had shown fifteen people whom the defendant might have asked and had not. The company claimed that the laws of Louisiana controlled, as the contract was made there, and that its interpretation and validity were governed by the laws of that State, and the question of diligence had not depended, did not depend upon the relative number of people asked and not asked, but upon whether those asked were such as were likely to have been able to give the desired information. The court below held that there was no negligence in New Orleans, but that there was negligence in Beaumont, and that the sixty days' clause had no application, but that the court was controlled by the statutes of the State of Texas, and rendered judgment for $1500. The Court of Civil Appeals in its decision just rendered held that the message was in the nature of interstate commerce, and that the sixty days' clause controlled and that the Texas statute had no application; that the telegraph company on the facts showed diligence. The decision of the lower court was reversed, and judgment rendered for the telegraph company.

PACIFIC COAST NOTES.

SAN FRANCISCO, Cal., Dec. 17, 1897.

THE SAN JOAQUIN POWER COMPANY will extend its electric transmission system to Hanford, Cal., and points between that place and Fresno.

MR. J. A. LIGHTHIPE is not now connected with the Finance & Construction Company, San Francisco, but will confine his attention to his duties at the head of the engineering department of the General Electric Company's Pacific Coast District Agency, with headquarters in this city.

POWER TRANSMISSION IN BRITISH COLUMBIA.—Mr. Wynn Meredith, with Hasson & Hunt, consulting engineers, has returned from Vancouver Island, British Columbia, where he was engaged in engineering work on the new electric power transmission for the British Columbia Electric Railway Company, of Victoria, B. C. One-thousand horse-power will be transmitted 12 miles at 10,000 volts. The alternating generators will be driven by water.

THE GAMEWELL FIRE ALARM TELEGRAPH COMPANY, New York City, through Mr. R. A. Rose, Pacific Coast agent, recently installed a six-circuit board in Tacoma, Wash., and changed the city's batteries over to a storage system, 300 cells being required. This company has been awarded contracts to install a Gamewell system in Portland, Ore. Two Standard boards will be installed, a four-circuit board on the East side and an eight-circuit board on the west side. The latter will be installed in the City Hall and the old plant will be remodeled to conform to the Gamewell system.

THE GAS QUESTION has raised a great commotion among the local newspapers, which report that 290 lives have been lost in five years from inhaling illuminating gas heavily impregnated with carbon monoxide, as the result of mixing the coal gas with a large proportion of water gas. The Board of Health has passed a resolution requiring monthly tests of gas for dangerous qualities. Charles L. Taylor, city gas inspector, was questioned at length by the coroner in some recent morgue cases, and testified that he had not made a practice of testing the gas for its poisonous effects, but only for illuminating power, etc. A great deal of public feeling has been aroused by the agitation and investigation.

IT IS REPORTED that the Alaska Treadwell Mine Company, Douglas Island, Alaska, will install an electric power transmission, capable of operating 600 stamps, which will be installed at a point beyond the Gastineaux Channel. There are 360 stamps in use in connection with the gold mines operated by the company, and 500 additional stamps will be erected during the next year and a half. The exact capacity of the electric plant has not yet been decided upon. It will be an alternating system; distance of transmission, 10 miles. The source of water power will be on the mainland, and the mains will be carried across the channel on a pile trestle work. There is a flow of about 1500 miners' inches in one of the streams available. The glacial origin of the streams makes the flow variable at different seasons.

CANADIAN NOTES.

MONTREAL, Que., Dec. 18, 1897.

SHERBROOKE, QUE.—It is rumored that the Sherbrooke Street Railway Company will extend its line to Little Magog Lake next summer.

AN ENGLISH SYNDICATE is negotiating for the control of the Belleville (Ont.) Street Railway, with a view to extending it to Tweed.

THE ATLANTIC & LAKE SUPERIOR RAILWAY COMPANY, who own the Lachute & St. Andrew's Railway, will convert it into an electric road and extend it to Carillon, Que.

ST. THOMAS, ONT.—The by-law to confirm an agreement between the City Council and the street railway company, for the electrification of the street railway, was carried by the ratepayers last week. The company agrees to build 6½ miles of track and to strengthen the Wilson bridge.

MESSRS. NOBLE & BARBER, electrical contractors, have started in business in Montreal, Que. The successors of the electrical supply business of C. W. Henderson, Bleury Street, are Taylor, Telfer & Co., who will commence business at the same stand.

MUCH INTEREST IS TAKEN in the proposition to build an electric railway from Bobcaygeon, Ont., to Peterboro. The scheme is to build a line to Scott's Mills, some 12 miles east, thence to Bucklorn and Peterboro. This would avoid expensive bridges. The cost is estimated at $200,000.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Dec. 15, 1897.

EXTENSION OF THE TIMMINS ELECTRIC SIGNALING PATENT.—It is rarely indeed that the Judicial Committee of the Privy Council advises Her Majesty to extend the period of letters patent for an invention in the United Kingdom. In order that an application for such extension may be successful, it must be conclusively shown that the invention is one of exceptional merit, and that the inventor has not been adequately rewarded. Last week the Judicial Committee found that on both these counts the 1883 patent granted to Mr. Timmins for a system of electric signaling on railways merited extension, and they have advised Her Majesty to extend the patent for another period of ten years. This system of signaling is employed on the Liverpool Overhead Railway and on one of the dock railways in South Wales, but owing to the difficulty in supplanting older systems that have already become thoroughly rooted in the railway systems of the country, Mr. Timmins has found his invention to be by no means a gold mine. It was stated in evidence that up to the present time he had lost £6000 over it.

ENGINEERING CONFERENCE.—There seems some hope of a settlement at last of the prolonged dispute between British engineers and their employers. It will be remembered by your readers that some ten or twelve days ago an engineering conference between the representatives of the Employers' Federation and the Amalgamated Society of Engineers was adjourned in order that a vote of the men might be taken on the resolutions of the employers. All along the employers have given way scarcely one bit, and even now they adhere to their original conditions of settlement. On the other hand, the men have voted by an overwhelming majority for the rejection of the masters' terms, which means that they still insist on the adoption of the eight-hours' day and restriction in regard to overtime, the number of apprentices and selection of operatives. Yesterday a sub-committee of the conference, consisting of three representatives on either side, seems to have come to some sort of amicable arrangement, and in a manifesto issued to-day the prospect of an early settlement is held out. I hope that by next week I shall be able to announce to your readers that this long-drawn and historic strike has come to an end.

THE ANNUAL GENERAL MEETING OF THE INSTITUTION OF ELECTRICAL ENGINEERS.—On Thursday evening last the Institution of Electrical Engineers held its annual general meeting under the presidency of Sir Henry Mance. In connection with the retirement of Mr. Webb from the secretaryship next February, the appointment of Mr. W. G. McMillan, F. I. C., F. C. S., late lecturer of metallurgy at Mason's College, Birmingham, was announced; and a motion was proposed and carried unanimously that in recognition of Mr. Webb's valuable services to the Institution during the past twenty years a pension of £300 per annum be allowed to him on his retirement from the office of secretary. The Institution is looking forward to the time when it will be able to meet in a home of its own. Your readers will, no doubt, remember that the meetings are now held in the magnificent house of the Institution of Civil Engineers. There has been a building fund in existence for some time, and this fund has now swelled to the respectable dimensions of £4639:13:7. It was announced that the Institution premiums would in future be increased, the £10 premium being raised to £25, and the £5 premiums to £10. There are also two additional premiums of £10 and £1 each, besides three new premiums for students, viz., one of £10 and two of £5 each.

French Notes.

(From Our Own Correspondent.)

PARIS, France, Dec. 8, 1897.

THE ELECTRICAL WORKSHOP OF THE ECOLE DES ARTS ET METIERS.—Strange to say the Ecole des Arts et Métiers of Aix and Châlons, which has been giving engineering instruction, has not had up to now electrical laboratories. This omission has just been filled, thanks to a subsidy of 200,000 francs, which M. Boucher, Minister of Commerce and Industry, has had settled upon it. Already, thanks to a fire which in 1895 destroyed part of the shops of the school at Châlons, they will be able, when reconstruction begins, to plan an installation on a scale becoming indispensable now that electricity is playing a part in the arts even more important than that taken by steam in 1840.

ELECTRICITY AT PARIS.—It can hardly be denied that Paris is behind in the application of electricity, and it is hard to see just where it will be able to make up the lost ground. In Germany all the large cities have immense central stations and are brilliantly illuminated with electric light, and their factories use only electricity for motive power. As to the installations of electric tramways they are almost countless. This state of things has resulted in electric energy being delivered to the consumer at an extremely low price, so that everybody can make use of it. This is by no means the case at Paris, and it is not alone foreign countries which have so far surpassed the capital. In St. Etienne, for example, there is a distribution of electric motive power which compels the admiration of all who see it. There is not a single weaver, ribbon maker or lace maker who has not an electric motor in his shop. At Paris electric energy is employed for almost nothing but lighting, and what a light! As to electric elevators or motors for any other purpose, we are just beginning; the rest is as yet to be done. In the whole of Paris there are only 750,000 incandescent lamps for the lighting of shops and houses. The public street lighting is done with only 15,000 arc lamps. The majority of the boulevards and streets are still lighted with gas, and when night comes the Bois de Boulogne and Vincennes are in darkness. As to the poorer quarters electricity is known in them oniy as a name. The causes of this state of things are: First, that the duration of the concessions given to electric companies has been too short; second, that electric current is sold at too high a price. As a matter of fact, the second of these causes is produced by the first. Paris is divided into six sections, for which the concessions, granted for only eighteen years, expire in 1907 and 1908. It is impossible in so short a time, in view of financial difficulties of all sorts, to undertake a complete programme of illumination. Electricity being so expensive there is little advantage in substituting it for gas. The current is sold at 0.15 francs (3 cents) per kilowatt hour. The average of charges is about 0.127, and they rarely come so low as 0.10 franc. Even at this latter price there is no advantage over the prices of gas. It is only in commercial establishments, expensive dwelling houses and industrial establishments that the central stations are able to do any business. Electric motive power is sold at entirely too high a price, and the stations have done little toward developing its utilization. M. Charles Bos, municipal councillor, has expressed himself very clearly upon the question of how to remedy this state of things, and is now seeking means to place Paris in her proper position in this regard. There seems to be but two solutions: First, control by the city of the rates of charges, and, second, prolonging the franchises of the illuminating companies. According to the advice of the city commissioners the city cannot take over the installations without danger of loss, since, with the exception of two, they are but poorly built. It would be necessary to rebuild the plants and renew the distribution systems. On account of the expenses of the coming exposition and the construction of the metropolitan railways this is hardly posssible. It seems necessary then to prolong the franchises, for unless this is done the illuminating companies will neither put in new conducting systems nor enlarge their plants, and the exposition will be poorly lighted. If these concessions are extended it is to be hoped that in a dozen years or so all the streets of Paris will be provided with electricity conductors, as they are at present furnished with gas pipes.

AN APPARATUS FOR FINDING BULLETS IN THE HEAD BY MEANS OF X-RAYS. At the meeting of the Academy of Sciences on November 22, M. Marey showed an arrangement designed by MM. Remmy and Contremoulin, to discover the exact point where a bullet is lodged in the skull. The method is that of two sources of Röntgen rays. The head of the patient is placed in a cubical box, upon one of the sides of which is fastened a plate, which of course receives two images of the bullet. At the same time three points on the face of the patient are marked, one upon the forehead and the other two upon the right and left jaws. These three points are exactly located in the interior of the box by means of metallic rods penetrating through one of its surfaces. Removing the box from the head and joining the five points thus obtained by wires, a simple geometrical construction permits the exact determination of the place of the bullet, with reference to the points marked on the face of the subject. By a specially designed compass the exact place that it occupies with reference to the cranial surface nearest to it may be at once determined. The results obtained by the application of this system to dead bodies have been found very exact, and recently two locations of bullets in the heads of persons wounded with a revolver were made. The surgeons discovered the bullets exactly at the indicated points.

General News.

New Incorporations.

THE PACIFIC COAST TELEPHONE COMPANY has been incorporated in Santa Cruz, Cal., with a capital stock of $25,000.

THE BOZEMAN STREET RAILWAY COMPANY, Bozeman, Mont., has filed articles of incorporation, with a capital stock of $20,000.

THE WASHINGTON & ANNAPOLIS RAILWAY COMPANY, Washington, D. C., has filed articles of incorporation. The incorporators are Edgar L. Marston, H. C. Knox, Elisha K. Camp, and others.

THE BALDWINSVILLE TELEPHONE COMPANY, Baldwinsville, N. Y., has been formed, with a capital stock of $10,000. The directors are William F. Morris, Hiram Howard, E. E Summey and others.

THE MONMOUTH TRACTION COMPANY, Freehold, N. J., has been organized to build an electric road from this place to Keyport, N. J. The incorporators are Edward Morrell, H. V. Massey and others.

THE BLOSSBURG ELECTRIC LIGHT & POWER COMPANY, Blossburg, Pa., has been formed, with a capital stock of $15,000. The directors are W. H. McCarthy, J. M. Gray and Walter T. Merrick, Blossburg.

THE AMERICAN TELEPHONE COMPANY, Allegheny City, Pa., has been incorporated, with a capital stock of $1,500. The directors are Xavier Witmer, Henry Witmer, D. C. Cawley, F. Kleersman and F. B. McMillan.

THE STANDARD ELECTRIC LIGHT, HEAT & POWER COMPANY, Avoca, Pa., has been formed, with a capital stock of $40,000. The directors are E. J. Jorden, A. H. Squier, B. F. Ziegler, Leon Schrager and L. R. Squier.

THE VICTOR INCANDESCENT COMPANY, New York City, N. Y., has been incorporated, with a capital stock of $100,000. The directors are Howard R. Brayton, Dewitt R. Roth, Montgomery Clark, Washington J. Schenck and Louis J. Lewis.

AN ELECTRIC RAILWAY COMPANY, in which Burlington capitalists are interested has been formed in Rutland, Vt. The officers of the new company are J. S. Pierson, president; F. C. Kennedy, vice-president. Capital stock, $300,000.

THE DAYTON, SPRING VALLEY & WILMINGTON TRANSIT COMPANY, Dayton, Ohio, has been formed, with a capital stock of $50,000. The incorporators are J. M. Wilson, Wallace Berryhill, J. M. Racer, George Truman and others.

THE CUMBERLAND TELEPHONE COMPANY, Cumberland, Wis., has been incorporated for the purpose of maintaining a local telephone exchange. Among the incorporators are Mayor S. M. Waterman, E. W. Miller, H. S. Cummings and F. Olcott.

THE AMERICAN DISTRICT TELEGRAPH COMPANY, Evansville, Ind., has been incorporated, with a capital stock of $2,000, by F. W. Samuels, manager of the Postal Company at Indianapolis; Frank M. Broad, manager of the Postal Company at Terre Haute, and others.

THE PARAGON ARC LAMP COMPANY has been organized at Berwick, Me., for the purpose of manufacturing and selling electrical and mechanical devices. The incorporators are: President, Charles C. Barton, Boston; treasurer, John R. Hanner, Boston, and others; capital stock, $10,000.

THE NEW YORK & QUEENS COUNTY ELECTRIC LIGHT COMPANY, Newtown, L. I., has been incorporated at Albany, N. Y. The directors are John Welz, Charles Zerwich, Anton Newberger and Siegbert Balaban, of Brooklyn, and John Niederstein, Jr., of Middle Village, L. I. Capital stock, $250,000.

THE STANDARD ELECTRIC COMPANY, of Cincinnati, Ohio, has been organized, with a capital stock of $20,000, for the purpose of manufacturing and dealing in telegraph, telephone and electric instruments. The incorporators are E. V. Cherry, John W. Herron, F. D. Lawrence, Francis X. Pund and George Puchta.

THE LANSING, ST. JOHNS & ST. LOUIS RAILWAY COMPANY, Lansing, Mich., has been organized to build an electric railroad from Lansing to St. Louis, Mich. The officers of the new company are: President, M.

V. Montgomery, Lansing; vice-president, A. P. Darragh, St. Louis; secretary, Frank L. Dodge, Lansing.

THE LONG ISLAND IMPROVEMENT & CONSTRUCTION COMPANY, Charleston, S. C., has been incorporated for the purpose of extending the electric railway across Cooper River to Mount Pleasant, to Sullivan's Island and thence to Long Island. Among those interested are J. S. Lawrence and H. W. Layton. Capital stock, $50,000.

THE BUSINESS MEN'S TELEPHONE COMPANY, of Oakland, N. Y., has been organized, with a capital stock of $5,000, to erect a local telephone line extending to all the prominent towns of Western New York. Those interested are: H. C. Farnum, general superintendent and president; L. A. Walker, secretary; H. E. Averill, vice-president and treasurer; George Campbell, Smith Clute, John Meyers, Robert Bennett and Vally White.

THE UNION EQUIPMENT COMPANY has been incorporated at Trenton, N. J., with a capital stock of $1,500,000, for the purpose of manufacturing electrical suppplies, building, equipping and operating street trolley lines. The incorporators are Frederick H. Hitchcock, Glenn R. Gardner and Francis J. Boyer, of New York; Frederick W. Hunter, of Cranford, and Frank G. Gourley, of Stamford, Conn. The principal place of business will be at Jersey City, N. J.

THE NEW YORK BEACH RAILROAD COMPANY has been incorporated at Albany, N. Y., with a capital stock of $50,000, for the purpose of constructing an electric street railway 5 miles long in the town of Southfield, Richmond County. The directors are: Albert Reynaud, New Dorp; Ernest G. Wightman, Stapleton; Charles N. Harris, William H. Welde, William D. Stratton, Robert Emmett, H. T. Ferris, A. S. Drake and James P. Egan, of New York City.

THE AMERICAN STOKER COMPANY, of Brooklyn, N. Y., was incorporated at Albany, N. Y., December 17, with a capital stock of $500,000. The directors are: Messrs. Royal C. Peabody, David H. Valentine, Alfred J. Couch, Frank H. Field, Henry Batterman, Hugh W. Fullerton and William S. Barstow, of Brooklyn. The new company will take over the business of the American Stoker Company, formerly of Dayton, Ohio, which has supplied mechanical stokers for a large number of electrical plants.

THE TELEGRAPH AND TELEPHONE.

DETROIT, MICH.—The State Telephone Company will establish an exchange at Flint.

GAYLORD, MINN.—The Sibley County telephone system has been completed, and tests of the same show it to work satisfactorily.

ELMO, TEX.—The Southwestern Telephone & Telegraph Company is constructing a telephone line from Terrell to Mineola and thence to Tyler.

ROCHESTER, ILL.—A telephone line will be built between Rochester, Breckenridge, Custer, New City and Pawnee by a syndicate of prominent business men who are residents of the towns named.

WASECA, MINN.—A company has been organized for the purpose of establishing a telephone exchange in this city. The rates, it is stated, will be $1.25 per month for private houses, and $1.75 for business purposes.

DULUTH, MINN.—The work of constructing a telephone line between the offices of the Mountain Iron and Oliver mining companies is now in progress. The Range mines will, in the course of time, be well provided with telephonic connection. The Duluth & Iron Range road has already made extensive arrangements of this character.

ST. LOUIS, MO.—It is reported that the Southern Bell Telephone Company made a proposition to the Hurricane Telephone Company, of Hurricane, W. Va., to join the Hurricane Company's long distance lines, which are being built through West Virginia, under the direction of Mr. E. R. Williamson, of Chain of Rocks, Mo. This is supposed to be the first instance where the Bell Company was willing and even solicited co-operation with an independent telephone enterprise. Mr. Williamson has been building extensive lines throughout the State of West Virginia.

COLUMBUS, OHIO.—Attorney-General Monnett has decided that the owners of the Central Union Telephone Company's telephones must pay taxes on the same, and instructions in accordance with this opinion have been forwarded to the county auditors throughout the State. The opinion of the Attorney-General states that the instruments are owned by the Bell Telephone Company, and are rented to the Central Union for $14 per year each. The Attorney-General states that from 22,000 to 25,000 instruments are in use in Ohio, and that the State should receive on them $80,000 a year. The Central Union Company has not been paying taxes on instruments on the ground that it did not own them.

ELECTRIC LIGHT AND POWER.

FREEPORT, ILL.—This place will issue $20,000 bonds for an electric light plant.

HURON, OHIO.—The town of Huron has concluded to put in an electric light plant.

LYKENS, PA.—The proposition to issue $12,000 for the erection of an electric plant has been defeated.

TOLUCA, ILL.—The Council has been petitioned to grant a franchise to establish an electric light plant.

SOUTH BOSTON, MASS.—The Boston Electric Light Company has decided to build a large plant in South Boston.

LOWELL, MICH.—The Peninsular Heat, Light & Power Company will, in the spring, erect a new 200-hp plant at Lowell.

CENTREVILLE, IA.—W. M. Peatman and D. C. Bradley are seeking a franchise to establish an electric plant to cost $20,000.

SPRING GREEN, WIS.—At the special election on the question of granting a franchise to put in an electric light plant, only seven votes were cast against it.

WILLIAMSPORT, PA.—An election will probably be held in February to vote upon the question of erecting an electric lighting plant.

ELIZABETHTON, KY.—The Council has under consideration the establishment of an electric light plant. Mr. L. Winterswith is mayor.

COFFEYVILLE, KAN.—The citizens of this place have voted to issue $17,000 in bonds for the purpose of building an electric light plant.

PORT HURON, MICH.—The plant of the Excelsior Electric Light Company was burned on the morning of December 17. The loss, it is thought, will be not less than $25,000.

SAN FRANCISCO, CAL.—It has been decided to install a complete electric light plant in the Diamond Head Lighthouse, and electric light will be used in the lantern after February 1 next.

GOSHEN, IND.—Mr. Louis M. Latta has been appointed receiver for the Citizens' Electric Light Company. The receivership was brought about by a disagreement among the stockholders.

WEST POINT, MISS.—The city of West Point has about decided to add an electric light plant to its water works, and is open for prices on electrical machinery. Mr. W. W. Robinson may be addressed on the subject.

PITTSBURG, PA.—At the next meeting of the Board of Prison Inspectors the contract will be let for establishing an electric light plant in the Western Penitentiary to cost $40,000. D. B. Oliver is chairman of the committee which has the matter in charge.

MILWAUKEE, WIS.—The City Council of South Milwaukee has instructed the city attorney to take steps to secure the annulment of the franchise of the South Milwaukee Electric Lighting Company on the ground that the company has not lived up to the terms of its franchise.

WASHINGTON, PA.—The Monongahela Valley Electric Light Company has applied for a charter giving it permission to furnish light and power to towns along the river from Redstore Creek to Elizabeth. Ernest W. Beach, Henry F. Gilg, Robert T. Rossell, Winfield B. Carson and George B. Motheral are interested.

ST. LOUIS, MO.—The Missouri Electric Light & Power Company, and the Edison Electric Company were consolidated on December 27 last under the name of the Missouri Edison Electric Company. A deed of trust on the entire property was given to the Knickerbocker Trust Company to secure the issue of $4,000,000 in bonds, to be applied as directed by the meeting of stockholders, held December 11 last.

NEWARK, N. J.—The Benjamin Atha & Illingworth Company, of this city, has completed arrangements for the erection of a large new machine shop and other buildings across the Passaic River from its present works at Harrison, N. J. The machinery in the new shop will be run by electric power, with independent motors for each tool. This new equipment is installed for the purpose of constructing rapid firing guns for the Government.

THE ELECTRIC RAILWAY.

ROCHESTER, N. Y.—A trolley line is projected from here to Canandaigua.

AMBLER, PA.—A trolley road is to be built from this place to Norristown.

SIDNEY, N. Y.—The new railroad company will erect a power house in this village.

LOCKPORT, N. Y.—It is proposed to build an electric railroad from Lockport to North Tonawanda.

LOCKPORT, N. Y.—It is rumored that the Erie Railroad will operate its line between Buffalo and Lockport by electricity.

PARKERSBURG, W. VA.—The Parkersburg City and Suburban Railway Company will construct an electric railway in this city.

KITTANNING, PA.—The electric railway between Kittanning and Ford City is an assured fact, and it will be built by Cleveland capital.

PHOEBUS, VA.—An electric road is to be built from this place to Fox Hill. Robert Paul, of Fox Hill, and E. M. Tennis, of Phoebus, are interested.

WORCESTER, MASS.—The Worcester & Clinton Street Railway Company is planning to begin work of building their electric road in the early spring.

WHITEHALL, N. Y.—C. I. Baker, of Troy, N. Y., can give information in regard to the proposed electric railway between Whitehall and West Pawlet.

YARMOUTH, ME.—An ordinance has been passed granting a franchise to the Portland & Yarmouth Electric Railway Company to operate its lines in the city.

DALTON, OHIO.—This place is to be connected by electric railway with Massillon and Canton. Right of way has been secured for most of the distance.

BANGOR, ME.—The Bangor, Orono & Oldtown Electric Railroad will erect a power plant near the city. Mayor Beal, of Bangor, is a director of the company.

CRANFORD, N. J.—President Chandler W. Riker, of the Westfield & Elizabeth Street Railway Company, has petitioned the Township Committee for a franchise for a trolley road.

BALDWINSVILLE, N. Y.—The Onondaga Lake Railroad Company has made application to the Board of Trustees for a franchise to build a railroad through the streets of that village.

COLLEGE POINT, L. I., N. Y.—An application for a franchise to construct a trolley line in College Point has been received by the Village Trustees from the Cross Country Railroad Company.

NEW CITY, N. Y.—The Nyack Traction Company has petitioned the Board of Supervisors for a franchise to construct an electric railway on the county road from this place through West Nyack.

MATAWAN, N. J.—It is reported here that a number of Philadelphia capitalists are interesting themselves in the building of a trolley line from Freehold, through Matawan and Keyport, to Long Branch.

SOUTHFIELD, S. I., N. Y.—The Staten Island Electric Railroad Company has applied to the Town Board of this place for permission to continue its line from South Beach to Midland Beach along the Boulevard.

THE SALISBURY (N. C.) STREET RAILWAY & ELECTRIC COMPANY, recently organized, has applied to the Board of Aldermen, of Salisbury, for a franchise to operate a street railway in that town.

MIDDLETOWN SPRINGS, VT.—A company has been formed to build an electric railroad connecting this place with Poultney, Fair Haven, etc. President, J. F. Pearsen, of Burlington, Vt.; treasurer, J. J. Flynn, of Burlington, Vt.

NEW BRUNSWICK, N. J.—The new line of the Brunswick Traction Company, between this city and Bound Brook, was formally opened on December 23. The line is 7 miles in length. The farmers along the route gave the first car an enthusiastic welcome.

LONG BRANCH, N. J.—The Board of Commissioners have granted a ninety-nine-year franchise to the Atlantic Highlands, Red Bank & Long Branch Electric Railway Company. The franchise gives the electric railroad the right to double its tracks.

KANSAS CITY, MO.—The Metropolitan Street Railway Company has decided to change the Fifth Street cable road to the electric system. The power will be transmitted from the new Riverview power house, and the cable power house on Ninth Street will be shut down.

WEST UNION, W. VA. A company of capitalists is making arrangements to build an electric road from West Union, the county seat of Foderidge County, to Middlebourne. It is the intention to extend the line to Sistersville to connect with the Ohio River Railroad at some future date.

PITTSBURG, PA.—The building of the Park Gate & Ellwood Street Railway is assured. The road is to run from the Pittsburg & Lake Erie & Pennsylvania Railroad down the Beaver River, past Rock Point picnic grounds, and through Ellwood City and Hazel Dell, and will be 5 miles in length.

GREAT BARRINGTON, MASS.—A petition has been filed by Herbert F. Keith, of Mount Washington, for the incorporation of himself and associates with authority to construct a street railway from some point in the town of Monterey, through Great Barrington, Egremont and Mount Washington, across the State line into the State of New York.

BALTIMORE, MD.—The City Passenger Railway Company has awarded the contract for the work of changing the motive power of the red and white lines of its system from cable to electricity to Messrs. Gill & Co., electrical engineers, Philadelphia. The contract calls for the completion of the work within ninety days. The change will require the erection of about 8 miles of double track overhead trolley line.

NEW YORK, N. Y.—The New Jersey Electric Railway Company, which operates trolley lines between Rutherford, Hoboken, Passaic and Paterson, has gone into the hands of a receiver. Mr. John L. Heins, president of the company, was appointed receiver. The application was made by the Mercantile Trust Company, of New York. It is stated that the company defaulted in the payment of interest on $4,000,000 of 5 per cent. bonds.

Personal Notes.

MR. J. HOPKINSON, the well-known English electrical engineer, informs us that he has removed his offices from Westminster Chambers, 5 Victoria Street, S. W., to Victoria Mansions, 26 Victoria Street, S. W., London.

MR. C. P. GEDDES, who for several years has been treasurer or the Interior Conduit and Insulation Company, has been elected assistant treasurer of the Sprague Electric Company, the new corporation recently organized in this city, as the result of the consolidation of the Sprague Electric Elevator and the Interior Conduit and Insulation Companies. Mr. Geddes has proved himself an able financier and a capable credit man, and is held in the highest esteem, not only by his associates, but also by those in the trade who have had dealings with him. Both the company and Mr. Geddes are to be congratulated.

Trade and Industrial Notes.

THERE ARE more items in the present issue under this head than usual. It has been the custom of The Electrical World for several years to invite some of the best known manufacturers and dealers to contribute at this season a few words as to their own business and the outlook for the coming year. The items based on these replies are this year included in this department.

MR. SETH C. ADAMS has opened an office in Utica, N. Y., to represent the Walker Company in that territory.

ELECTRICAL NOVELTIES in profusion are described and illustrated in a little pamphlet just issued by the Ohio Electric Works, Cleveland, Ohio.

THE KENT ELECTRIC MANUFACTURING COMPANY, Worcester, Mass., is bringing out a new line of water motors in addition to its new productions in battery motors.

THE DIAMOND ELECTRIC COMPANY, Chicago and Peoria, Ill., informs us that its business in wattmeters and transformers is extending in this country and in Canada, and that it has never been better than it is this fall. The company has encouraging prospects for 1898.

A DESIRABLE CALENDAR.—The Magnolia Metal Company, 266-267 West Street, New York, has issued a handsome desk calendar for 1898. It is provided with an easel support to stand on the desk or table. The frame is of white celluloid, and the monthly calendars are printed on removable cards.

THE PRATT & WHITNEY COMPANY, Hartford, Conn., states with gratification that the volume of its business during 1897 was larger than the average for the past six years, and about one-third of it was with foreign houses. The anticipated improvement in business in the United States has not got beyond the creeping stage as yet.

THE MURRAY IRON WORKS COMPANY, Burlington, Ia., reports that it closed the year 1897 with some heavy shipments of machinery, which wound up the year's contracts and cleared the decks for 1898. The entire plant has been operated full time throughout the fall, and the Corliss engine works and boiler shops have had to run overtime.

MESSRS. M'KINLOCK & CAMP, agents of the successors of the Metropolitan Electric Company, 175 Randolph Street, Chicago, Ill., are handling the new Standard dry battery, manufactured by William Roche, the pioneer dry battery maker. They claim it to be superior to any dry battery on the market, and that a sample will demonstrate this.

THE CARD ELECTRIC COMPANY, Mansfield, Ohio, manufacturer of electrical apparatus, has experienced an improvement in business during the last year, and has no reason to complain. Mr. Frank A. Rogers, the general manager, is sanguine as to the future, and is of the opinion that the company's business will greatly increase during the new year.

THE WARREN ELECTRIC & SPECIALTY COMPANY, Warren, Ohio, advises us that it has entirely recovered from the effects of the fire which partially consumed its laboratory on November 18, last, and is now ready to fill orders promptly. It offers apologies to any customer, the shipment of whose order has been delayed, by reason of the fire.

LAVA INSULATION, as manufactured by the D. M. Steward Manufacturing Company, Chattanooga, Tenn., is used very extensively by all the principal electric manufacturing companies in the country, and hundreds of smaller ones, too. Where high insulation is required in a small piece, and where high voltage is used, the Steward lava is said to be unexcelled.

THE ELECTRIC RAILWAY HOT BLAST BOND BRAZER, made by the White Manufacturing Company, 158 Indiana Street, Chicago, Ill., is a powerful portable labor saving device. It is made especially for brazing copper bonds between the rails of electric railways. The company also makes a line of hand torches for various uses, including one for electrical work.

THE BRUSH ELECTRIC COMPANY is the pioneer in arc lighting, and it would surprise many to know how much Brush apparatus is still sold. General Manager S. M. Hamill, who is now permanently located at Schenectady, N. Y., has grown up with the Brush Company, and reports the outlook for he sale of Brush machines for 1898 as exceedingly promising.

THE DEMAND FOR WINDOW REFLECTORS IS INCREASING.—Mr. George Frink Spencer, general manager of the firm of I. P. Frink, New York, manufacturer of Frink reflectors, reports a large sale of their special window reflector, sectional glass cluster reflector and reflecting shades, and a normal output of reflectors for lighting churches, theatres, halls, etc.

THE AMERICAN DISTRICT STEAM COMPANY, Lockport, N. Y., has just closed a prosperous season, introducing its exhaust heating system for use with quite a large number of the electric light and railway companies in the country. It is said that companies that have had time to develop their heating are paying their station fuel bills for the year out of sales of exhaust steam.

THE WESTERN ELECTRIC COMPANY, Chicago, has been made exclusive agent in the territory west of Pittsburg for the Tuerk alternating-current ceiling fan, made by the Hunter Fan & Motor Company, Fulton, N. Y. It has also been made exclusive agent for the car heaters and office heating devices manufactured by the Globe Electric Heating Company, Philadelphia.

MR. JOHN T. M'ROY, manufacturer of vitrified conduits, Chamber of Commerce Building, Chicago, and 253 Broadway, New York, sent out very handsome Christmas presents to his friends. The presents consisted of what are now almost necessities to business men, fountain pens, and all who received them will be sure to remember Mr. McRoy pleasantly during the whole of 1898 and afterward.

MESSRS. J. JONES & SON, 67 Cortlandt Street, New York, state that their business was never in a more flourishing condition. Since the beginning of the fall trade their factory has been continually taxed and working to its utmost capacity. At the present time they are unable, working night and day, to fill orders with the desired promptness. They consider the outlook for 1898 most promising.

THE PELTON WATER WHEEL COMPANY, San Francisco and New York City, reports a steady increase of business, particularly from foreign sources. As an indication of the diversity of its trade, it may be mentioned that at the present time it has foreign orders in hand from Mexico, Central and South America, Japan, Java, Australia and India. The prospects for the year 1898 are most encouraging.

MESSRS. D. L. BATES & BROTHER, Dayton, Ohio, manufacturers of the "Bates" electric ceiling fans, have devoted a great deal of time to the development of electric fans, and are prepared to furnish ceiling fans for direct or alternating current, wound for any voltage. They have lately added to their line a desk fan, for direct current only, which they claim to be the most efficient and ornamental fan on the market.

AMONG THE ENGINES AND BOILERS shipped by the Murray Iron Works Company, Burlington, Ia., at the close of the past year were the following: One 700-hp cross compound, direct connected Corliss, for a Texas street railway; one 450-hp Corliss, for a Missouri municipal lighting plant; one 150-hp Corliss, for an Iowa municipal electric lighting station, and one 70-hp high pressure boiler, for an Iowa electric light plant.

MESSRS. ZIMDARS & HUNT, manufacturers of electric light and power specialties, 127 Fifth Avenue, New York, report the outlook for 1898 very promising. This concern has recently had installed a lot of new and improved machinery, which, in addition to the old, enables them to keep up with their rapidly increasing business, and to maintain the enviable reputation they already have for turning out none but the highest grades of apparatus.

THE CHICAGO BELTING COMPANY, Chicago, Ill., reports that business with it is booming, and that it is half a month behind in its orders. If they continue to come in in that way the company states that it does not know when it will be able to catch up, although it is running night and day in an endeavor to get even. Early in December it closed three contracts for 1898, which will keep the company's facilities pretty well taxed to fill.

THE ELECTRIC APPLIANCE COMPANY, past, Chicago, is congratulating itself upon the record that is being made by its sta. weatherproof wire. Although this wire has been on the market for about ten years, there is not a single recorded case, it states, where the insulation has not given the very very best of satisfaction. O. K. weatherproof insulation has never been known to come off of the wire, and wherever used is good and hard after five or ten years of service.

THE L. A. CHASE & CO., Boston, has made itself more conspicuous during the year 1897, and its business has been greater than ever. The Elden Alternating Machine Circuit Breaker, of which it is sole selling agent, has been one of its particular specialties, and the sales of this device have been unusually large. Mr. Sears B. Condit, Jr., manager of this company, is too well known to require any words of commendation. If anybody can get business he can, and he gets it right along.

THE BRODIE ELECTRIC COMPANY, Manchester, N. H., is doing a large business in the "Brodie" single-pole primary switch and cut-out for use with transformers. They are made entirely of porcelain and easily wired. The "Brodie" insulators are made in all styles, and are said to give much satisfaction. The company repairs electrical apparatus of all kinds. Its factory is now located in new and spacious quarters directly opposite the railroad depot. It has enjoyed a prosperous year.

THE FITCHBURG STEAM ENGINE COMPANY, Fitchburg, Mass., reports that its business is increasing, and that it is running on full time, with a full force of men. Prices are low, but they are a little bit stiffer, and customers seem to be more willing to buy the best goods. Much more inquiry is noted, and the prospects are good for the opening year. The company has received many orders for foreign shipment, and very satisfactory letters appreciating American workmanship.

MESSRS. LARGE & TWINING, 321 Chestnut Street, Philadelphia, Pa., state that the present outlook in their line is quite promising. Their factory has been running overtime for the past month, and they have plenty of orders for future delivery. During the past year they installed switchboards in various buildings in and around Philadelphia, Atlantic City, Bristol, Pa., and other places, and many others are in course of construction. Altogether, the outlook for 1898 is very good.

THE AMERICAN ELECTRIC HEATING CORPORATION, Cambridgeport, Mass., has had a most prosperous year in 1897. Its car heaters and electric heating specialties have been in increased demand, and acquired additional deserved popularity. The Universal Enamel Field Rheostat has proven a winning specialty. The energy of General Manager Ayer has been taxed to the utmost, but he has been equal to all emergencies, and the year 1898 opens most auspiciously for him and his company.

MR. ROBERT A. KEASBEY, 54 Warren Street, New York, dealer in Magnesia sectional covering, has issued a wall calendar for 1898; also a neat little pamphlet entitled "House Heating Hints." The calendar contains a very handsome lithograph of strawberries scattered on the table after falling out of a box. The coloring is very natural. The house heating hints are very timely at this season of the year, and if they are acted upon many people will learn how easily they can heat their dwellings.

MESSRS. MARIS BROTHERS, manufacturers of cranes, portable hoists, overhead track, trolleys, etc., Philadelphia, Pa., report that the outlook in their line of business is good and many inquiries are being received. Business during the latter part of 1897, they state, has been rather disappointing, but they are full of hope for the future. They have just established themselves in their new plant, and can now handle cranes of any span and capacity. They expect to be soon running to their full capacity.

THE DIAGONAL PISTON ROD PACKING, manufactured by Mr. Charles A. Daniel, Philadelphia, Pa., is recommended to the trade for the excellent qualities it is said to possess. In its manufacture the best materials are used, and from it long life may be expected. It is claimed by Mr. Daniel that by its use friction is much reduced, and that it will run with a loose gland. It is known in the trade as Daniel's Patent P. P. P. Diagonal Rod Packing, and is made for steam, oil, water, air, ammonia, etc.

THE LE VALLEY VITAE CARBON BRUSH, manufactured by the Le Valley Vitae Carbon Brush Company, 39 and 41 Cortlandt Street, New York, is stated to be non-sparking and does not injure the commutator in any manner. The brushes are used with satisfaction in some of the largest central stations and power plants. The Gold Medal Commutator Compound, made by this company, is made for use in connection with metal brushes. It prevents sparking and cutting, but does not gum the brushes.

THE ANCHOR ELECTRIC COMPANY, Boston, certainly need not be ashamed of its business during 1897, which has been exceptionally large and most satisfactory. The Anchor switches and other specialties have secured a strong foothold throughout the entire electrical field, and wherever once used repeat orders have always followed—the best of testimony as to their merit. In electrical suppplies generally the Anchor Company has gained an enviable reputation, and enjoys a deservedly large patronage.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, reports that its business during 1897 was nearly double that of any previous year. It has entered the "Central Station" field with a 220-volt direct-current generator with success. It has also competed for street railway work, and now has a number of street railway generators in successful operation. The company thinks there is every indication of a heavy business in 1898. It has made several additions to its plant, and is in shape to handle the increased business.

THE BELKNAP MOTOR COMPANY, Portland, Me., reports increased and better business during the year 1897 than in any year of its existence. Its dynamos, motors, electric passenger and freight elevators are recognized as standard manufactures, while the Chapman Voltage Regulator has proven a winning card from the time it was introduced. General Manager George W. Brown is a most careful executive, and possesses just the business energy to obtain for the manufacturers of this company a strong foothold.

THE WEBSTER CHEMICAL COMPANY, 400 Sibley Street, St. Paul, Minn., is in a line of business that contributes much toward one of the best means of advertising, namely, the coloring of incandescent lamps for illuminating and advertising purposes. Ordinary lamps are easily and cheaply colored by using "Crystal Chemical Coloring," a compound made and sold by the Webster Chemical Company. The company reports large sales of this coloring matter all over the United States and Canada, as well as in thirteen foreign countries.

THE STERLING SUPPLY & MANUFACTURING COMPANY, 141 East Twenty-fifth Street, New York, has made preparations for an increase of business during the new year. It has lately enlarged its manufacturing facilities, and now possesses a well appointed shop. It produces the well-known Sterling fare registers, a full line of overhead material for electric railways, sand boxes, fenders, etc. President J. H. Carson is a hard worker, and it is mainly through his enterprise and progressive idea that the company has attained the prominance it enjoys.

MR. AUGUST BECKER, Boston, designer and engraver of name plates for electrical apparatus and other manufactures, has done a very nice business during 1897. In the electrical field his customers include some of the largest of the manufacturing companies, which is also the case in the general manufacturing lines. Mr. Becker himself supervises the manufacture of every nameplate in order that full satisfaction may be given customers, and the testimonials which he has in his possession are a sufficient guarantee to any firm or corporation desiring nameplates.

THE DAVIS ELECTRICAL WORKS, Springfield, Mass., remembered its friends at Christmastide by sending them a wooden box, enclosing a bunghole electric lamp. The construction of the lamp is unique. The globe is like any other bunghole lamp globe, but instead of a vacuum it enclosed a liquid of a brownish-amber color. Access to the liquid is afforded by means of a cork in the base of the lamp. With the lamp came these directions: "To be taken before meals or on retiring. It is 'over seven,' and able to speak for itself." This presumably refers to the liquid in the bulb.

THE BIBBER-WHITE COMPANY, Boston, reports a remarkably successful year and a volume of business beyond even its most sanguine expectations. Aside from the sale of Crocker-Wheeler apparatus, of which it is the New England agent, and electrical supplies generally, it has furnished the entire electrical equipment for at least six good sized street railways in New England, and its business in this direction for the year 1898 promises even greater possibilities. Mr. C. E. Bibber deserves a great deal of credit for such results, as they are mainly due to his indefatigable energies, ably assisted by Treasurer Brown.

THE PETTINGELL-ANDREWS COMPANY, Boston, has had during 1897 the most prosperous year of its existence. Old customers have been retained and new ones have been added to the list. Among the oldest of the electrical supply houses its reputation for fair dealing has been most carefully sustained, and, if possible, increased. It has long been regarded as the representative establishment of its kind in the United States, and in New England its name with the electrical trade is a household word. President C. B. Price and Treasurer D. A. Andrews, Jr., may certainly feel proud of the outcome of their active labors.

MESSRS. WHITMAN & COUCH, Boston, manufacturers of telephones, switchboards and telephone supplies, have had an excellent business during 1897, and the new line of telephone apparatus and supplies which this firm is placing on the market argue unquestionably that the year 1898 will be unusually prosperous. The "best in the market" is the motto of this firm, and the liberal orders which it has received are evidence that those engaged in the telephone business believe in this motto. Both Mr. Whitman and Mr. Couch are young men, and possessed of those active and energetic qualities which always command success.

THE FERRACUTE MACHINE COMPANY, Bridgeton, N. J., is quite busy and running its works full-handed. The prospects are good for business during the coming year. The company is constantly adding new lines and styles of presses to its already large list, and it makes a number of presses which are especially adapted for electrical work. It has recently sent several presses to electrical factories in Europe. The company has fitted up its die shops with special machines for making armature disc dies from improved designs, and is now designing a much larger and heavier machine than its present style for notching armature discs.

THE "PALMER SET" of students' electrical instruments, manufactured by the Palmer Electrical Instrument Company, 26 North Seventh Street, Philadelphia, is designed and specially made to meet the requirements of teachers instructing students in practical electricity by the laboratory method. The instruments are neat, durable, practical and moderate in price, with no multiplicity of parts, yet flexible and capable of illustrating several hundred experiments from which all the fundamental principles of the subject can be deduced. This company also manufactures instruments for teachers, which greatly facilitates the lecture room demonstration.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, Ill., reports: "Our records of the past year have shown an ever increasing volume of business and an unprecendented number of modern exchange systems installed and long distance service lines equipped. We close the year with contracts calling for future delivery of apparatus to such an extent that we are largely increasing our manufacturing facilities, and with our present force working overtime in every department. The success of the well equipped and well managed independent telephone companies during the past year has been phenomenal, and the movement has become national in character."

MR. WILLIAM WRIGHT, 939 Monadnock Building, Chicago, general selling agent for the E. G. Bernard Company's apparatus, Mayo alternators and the Lynn Incandescent Lamp Company, has branched out into the second-hand bargain business. He will handle first-class high-grade dynamos and motors. He has now on hand 200 machines of various sizes. The motors range from 1 to 300 horse-power; direct-current generators from 10 to 3000 lights; alternating-current dynamos from 350 to 3000 lights and arc dynamos from 6 to 200 lights. He also has boilers and steam and gas engines. Mr. Wright is able to completely equip electric light and power plants of any size.

MR. T. J. SMITH, manager of the Manufacturers & Inventors Electric Company, 96-98 Fulton Street, reports in his characteristic fashion that "after more

than 1000 days of a constant and frigid winter, a softening process appears to be at work on the earth, and patches of sparse green light up the surface here and there in spots where favoring conditions focus the sun. The dwellers of the zone are beginning to move less timidly about, throwing back their furs to extend a readier and a warmer hand to grasp the hand of their fellow man. Collections still hard; credits easier, and business more plentiful, but prices abnormally low. Those who live will doubtless presently get grass."

THE SPRAGUE ELECTRIC COMPANY, New York, has closed the contract to install seventeen electric elevators in the Park Row Building, now being erected at 17-21 Park Row, New York. Of these elevators ten will be used for passenger service, two for the towers and five for sidewalk and freight. The specifications of the electric equipment for this huge building, which will be thirty stories in height, provide for 7500 lights, the generating plant to be divided as follows: Two units of 200 kilowatts; one unit of 100 kilowatts, and one of 75 kilowatts—all direct-connected. The building is being erected by the Ivins syndicate. Mr. R. H. Robertson, 160 Fifth Avenue, New York, is the architect.

MESSRS. K. M'LENNAN & CO., Chicago, state that the year with them has been an epoch in itself; it marked, they say, the change of Gale's commutator compound as a specialty to a staple article; from an article used in few plants to one of general use. At the close of the year, they report, it is in regular use by nearly every power plant and central station in the United States and Canada, and is kept in stock by every supply house. During the year the firm established agencies in Sweden, Norway, England, France, Germany, Italy and Japan. Next year the company expects to be able to report that every power plant and central station and all the isolated plants use Gale's commutator compound.

MESSRS. E. H. KELLOGG & CO., 243 and 244 South Street, New York City, manufacturers of anti-corrosive cylinder oil, state that this oil has been in use for forty years and has given uniform satisfaction. It is very extensively used in England, the London & Northwestern Railway Company having consumed over 10,000 casks of it. By the use of this oil economy is said to be effected in quantity, cleanliness, labor, power, fuel and wear and tear. This oil is used on the steamer "Kaiser Wilhelm der Grosse." Messrs. Kellogg & Co., make another grade of oil besides the above named, which is used for all general machinery outside of cylinders, light or heavy, and is especially recommended for dynamo and electric machine work.

THE PREVENTION OF BOILER INCRUSTATION and corrosion is one of the most important problems the steam user has to deal with, and many have been the devices and methods produced to accomplish this much desired result. The efficiency of Lord's boiler compounds is well known. By their use the life of a boiler is prolonged; fuel is saved; repair bills are reduced, and the boilers are enabled to use the full maximum amount of furnace heat for useful effect. Mr. George W. Lord, Philadelphia, Pa., manufacturer of these compounds, guarantees them to be absolutely free from acids and other harmful substances that can injure the iron. A pamphlet issued by Mr. Lord gives a good deal of valuable information on this subject.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., did not forget those of its friends who enjoy the fragrant weed in the distribution of Christmas remembrances. The company sent out neat little boxes containing bunghole lamp bulbs, in each of which was enclosed a fine Havana cigar, neatly done up in tinfoil. The cigar was named the "Monarch," after the Monarch lamp, and the company in extending the compliments of the season added the timely suggestion, "should you need incandescent lamps this winter suppose you try the Monarch, which we guarantee to burn as evenly, with but little more current, with a brighter light and much longer service than the one enclosed." The base of the lamp is removable and forms the cork.

THE CUTTER ELECTRICAL & MANUFACTURING COMPANY, Philadelphia, Pa., states that great strides have been made in the circuit breaker business during the past year. It now has instruments breaking instantly currents of from 5000 to 8000 amperes, and not only in single and in double pole has its line been extended, but also in double pole, double coil and in triple pole. Engineers all over the country are, it says, invariably specifying I—T—E circuit breakers, and demanding the same sort of protection against underloads as well as against over and underloads, combined in the same instrument, for both direct and alternating current service. The Cutter Company states that its efforts have been amply rewarded by the success attained in its particular line of manufacture.

THAT THE "TWO BALLS" ADJUSTABLE HANGERS for incandescent lamps, gotten out by Mr. M. I. Vought, La Crosse, Wis., is filling a long-felt want is evidenced by the fact that the manufacturer has been constantly behind with his orders for the last sixty days. These hangers are being sent out on ten days' approval to all responsible parties in dozen lots. It is stated that they have actually cut the meter bills in two in many cases by making one light do better work by getting it where it is needed than three or four would do on the usual chandelier or fixture. The strong points of this simple arrangement are the facility of raising or lowering the light and placing it at any angle; there are no springs to break and no mechanism to get out of order; works well on any cord, and sustains any shade. It is finished in various styles.

MR. W. J. BERG, electrical engineer and contractor, 176 Broadway, New York, is one of the old timers, his record dating back several years. Among the recent contracts closed by Mr. Berg for equipment and installation in New York City are the following: American Railway & Supply Company, Chesapeake & Ohio Railway Company, Continental Match Company, Detwiller & Street Fire Works Manufacturing Company, Diehl Manufacturing Company, Hoffman Club, Ice Palace Skating Company, Knickerbocker Trust Company, Lotus Club, Metropolitan Plate Glass Insurance Company, New York Commercial Company, New York Life Insurance Company (Met. Dept.), New York & Long Branch Steamboat Company, Seth Thomas Clock Company, Simpson, Crawford & Simpson, Stern Brothers & Co., United States Beer Brewery, Winchester Repeating Arms Company and many others.

VENTILATING MOTORS AT THE ASTORIA HOTEL.—The electric ventilating equipment of the Astoria Hotel in New York City is on a scale commensurate with the WORKS of that famous caravansery. All the impure air from the boiler and engine rooms, the kitchens and other similar places is exhausted through eleven air shafts running vertically through the building, terminating in large ventilators on the roof. On the top of each shaft is placed one of the C & C Electric Company's ventilating combinations, each combination consisting of a Blackman exhaust wheel, to which is direct-connected a C & C latest type ventilating motor. The ventilating wheels range in size from 48 inches to 72 inches in diameter, and the motors are designed to drive them at any one of four speeds, the speed control being secured through a system of field commutation. This installation of electric ventilating combinations is said to be the largest of its kind in the world.

THE K. & W. COMPANY, Pittsfield, Mass., manufacturers of Hardy incandescent lamps, hangerboards, dynamo brushes, spark arresters and commutator compounds, reports that the year 1897 has shown a steadily increasing business. During the past year the company has increased its capital stock and engaged in the manufacture of incandescent lamps, Mr. Salem M. Hardy, a lamp manufacturer of many years' experience, having associated himself with the company. The lamp department is running on full time, and a large number of orders is being received for the Hardy lamp. The new plant of the K. & W. Company is now in full operation, and as for equipment the lamp department and general manufacturing departments are in a position to execute orders with an unusual degree of promptness. The executives, Messrs. W. A. Whittlesey, F. R. Whittlsey and John H. Kelman, are giving close attention to the business of this company, and a successful future seems assured for it.

PARTRICK & CARTER COMPANY, of Philadelphia, Pa., has been in the electrical supply business for thirty-one years, the business having been originally started in 1867. The record of this firm is an honorable one, of which its members may be justly proud. Although the oldest house in the trade, it is in the front in progress and enterprise, and this is evidenced by the wide use of the apparatus which it manufactures. The leading department of the business, house goods, includes the well-known patent needle annunciators, so popular with the trade. Partrick & Carter Company also makes and handles all kinds of electrical supplies. The partners, Messrs. Franklin S. Carter, Charles M. Wilkins and E. Ward Wilkins, have been connected with the firm since its early days, and have kept step with the march of progress in the electrical business. They enter the new year full of hope and with a determination to make the future show even greater success than the past.

THE E. G. BERNARD COMPANY, Troy, N. Y., states that if the business of the last three months of 1897 is any criterion, it is inclined to believe that during 1898 everybody will have all the business they can possibly do. The company reports that it has refused at least four months' business within the last six or seven weeks on account of its inability to fill orders within the required time. At the present time the company is quite busy with orders from all sections of the United States, and has lately been favored by the Government with contracts for two special equipments, one for the Army Department and the other for the Lighthouse Department. A number of the company's orders are repeat orders from customers, without competition, which is a very positive indication to the company that its apparatus is giving satisfaction. The year 1898, Mr. E. G. Bernard thinks, will prove a most satisfactory one to those engaged in the electrical business.

THE AMERICAN RHEOSTAT COMPANY, Milwaukee, Wis., has enjoyed a rapid growth since its incorporation in the spring of 1896. The directors of the company lately found it necessary to vote an increase of the capital stock to $25,000 to enable the company to take care of its constantly increasing business. Its officers are all progressive business men of ability, and have been untiring in their efforts to make the business a successful one, and the popularity of the "American" rheostats is a sufficient comment upon the result of their endeavors. It is said that some of the largest motor manufacturers in the country prefer the "American" rheostat above all others, and accordingly buy their supplies exclusively of this company. The officers of the company are as follows: Frank R. Bacon, president; F. E. Herdman, vice-president; J. Gilbert Hickcox, secretary and treasurer. A well-equipped plant will shortly be erected, and the factory will then be moved from its present quarters. The company expects then, with its improved facilities, to materially increase its output.

THE MERRITT ELECTRIC COMPANY, Middleton, Mass., in its specialty of refilling incandescent lamps by the Merritt system, is doing a very prosperous business. The Merritt Company is well and favorably known to the electrical trade, having been formerly located at Lynn, Mass. It removed to Middleton about a year ago into a spacious, well-equipped factory, since which time its business has grown to proportions even beyond the sanguine expectations of its management. Its customers include some of the larger electric lighting and street railway companies and isolated plants of the country, very many of whom have given, cheerfully, testimonials of complete satisfaction relative to the Merritt Company's process of refilling lamps and the excellent results obtained from them. Mr. Merritt's knowledge of incandescent lamp manufacture is most thorough, and he has applied himself during the past year more closely than ever, so far as details of the business are concerned. This fact, added to the new business management, which became identified with the company on its removal to Middleton, explains the successful year's business of this company and speaks favorably for a materially increased business during 1898.

THE BRYAN-MARSH COMPANY, whose main office is in New York, with its factory at Malboro, Mass., and branches in Boston, Chicago and San Francisco, reports the largest fall and winter trade in Imperial incandescent lamps that it has ever known. Since September its factory has been worked twenty-two out of twenty-four hours a day, and still continues in this enviable position. The outlook for the coming year is even brighter, orders for upward of 2,000,000 incandescent lamps having already been booked for future delivery. Its Western outlook is especially bright, many large plants which have heretofore been buying hand to mouth now placing future orders with confidence. It is a wholesome indication of a general business revival that orders for small units of light used in residences and by many of the smaller consumers are

now in greater demand than for some time past, and while the volume of its trade is mainly confined to the larger central stations, yet there has been a marked increase in the orders from the smaller stations. The company estimates that its business druing 1898 will have more than doubled, and with this in view it is making a large installation of special automatic machinery to enable it to increase its output. The business of the company is confined exclusively to incandescent lamps, the variety manufactured being, it is said, greater than that of any other factory in the world. The street series and arc series lamp department, though only developed during the past two years, now ranks but second to the multiple lamp department.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY reports that the prospects of electrical business, both in this country and abroad, are the best it has ever known in its experience of a dozen years. The foreign business promises to make one of the most important departments of the company. At the present time the factory has orders from Scotland, Spain, Siam, Cuba, Belgium and other foreign countries. The year 1897 showed a steady growth in large undertakings, and of these many of the largest and most important, scientifically and commercially, were awarded to the Westinghouse Company. This company is, for instance, building five 5000-hp generators for the enlargement of the famous Niagara plant, and fifteen 5000-hp generators for the huge undertaking of the St. Lawrence Construction Company. It is an interesting fact that no other concern in this country has ever built generators of more than half the capacity of these Westinghouse giants. Another important contract was that for the electrical and mechanical equipment for the Boston Terminal station, which will be completed by the allied Westinghouse interests without the sub-letting of any contracts to other firms. In railway business the Westinghouse Company made a significant advance during 1897. Its No. 49 motor for street cars has been generally adopted. But the new departure in Westinghouse work is the establishment of a detail department, which enables the company to make a bid for the small items of electrical manufacture, arc lamps, house meters, integrating meters, switches, rheostats, lighting arresters and so on. Heretofore the Westinghouse Company has dealt chiefly with large work. It has already enlarged its facilities in that direction, and is now actively taking up the manufacture of every sort of electrical apparatus. At the moment of going to press the news comes that the Pennsylvania Railroad is about to develop electrical transit on a large scale by means of Westinghouse equipment.

WHAT HE WOULD DO IF HE WERE RICH.—I first subscribed for THE ELECTRICAL WORLD in February, 1891, and have not been without it since. This city has three central stations, two isolated plants, two telephone companies and 6 miles of trolley. Yet there are three men in the town who never read THE ELECTRICAL WORLD. I know this, not because they told me, but from reasoning by induction. One of them, a doctor, knew nothing of the properties of Röntgen rays, and the other two, both business men, had never talked through a telephone. If I were a rich man I would send all three of them THE WORLD for a year. As it is I lent the first mentioned gentleman a bound volume of THE ELECTRICAL WORLD. The other two, there being no possible help for them, I have solemnly concluded to let die in their sins. Don't forget to send the paper right along. It reaches us Monday mornings, and usually, when I get to the office, the typewriter and office boy are quarreling over it, while the cat is calmly umpiring the trouble from her nest in a pile of back numbers on the desk top. Let me join with your thousands of readers in wishing THE WORLD a prosperous New Year. W. W. Waters, superintendent City Electric Light Plant, Santa Cruz, Cal., December 18, 1897.

Business Notices.

TO SUNNY CALIFORNIA every Saturday night during the winter months. Personally conducted tourist car excursions, organized by the Chicago, Milwaukee & St. Paul Railway, start from Chicago every Saturday at 10 o'clock P. M., and run through Omaha, Lincoln, Colorado Springs, and Salt Lake City to Sacramento, San Francisco and Los Angeles, via the popular midland tourist car route. Each car is accompanied by an intelligent and obliging courier, who makes himself useful to all the passengers. This is an entirely new departure in tourist car service, and is highly approved by hundreds of California passengers. A sleeping berth costs but $6, and the railroad ticket is proportionately cheap. Apply to the nearest coupon ticket agent for an illustrated time table folder of the midland route to California, or address E. F. Richardson, General Agent, Passenger Department, New York, for further information.

Illustrated Record of Electrical Patents

UNITED STATES PATENTS ISSUED DECEMBER 21, 1897.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

595,693. SUSPENSION OF AERIAL CABLES; G. Cameron, Boston, Mass. App. filed July 24, 1897. An improvement in the art of erecting aerial cables, which consists in continuously drawing the cable up and along a single suspension wire without obstruction or interruption to a horizontal position while suspended from said wire by permanent hangers, which are successively attached to the cable and wire as the former is brought into proximity with the latter during its movement.

595,695. ELECTRIC ACCUMULATOR; C. P. F. Clerc and A. G. Pingault, Paris, France. App. filed Dec. 5, 1896. In an electric accumulator, the combination of plates carrying active material, perforated non-conductive coverings surrounding said plates on their sides and bottoms, whereby when the plates and coverings are lifted out any active material which may have become loosened from the plates will be taken out also, an insulating cell inclosing said parts, an inclosing case having a cover, a caoutchouc or similar sheet on the lower side of the cover pressing against the end of said cell, and forming a cover for it also.

595,731. ELECTRIC MOTOR; M. B. Pengent, Cambridge, Mass. App. filed March 31, 1897. In a portable motor for small work, the combination of a bottle-shaped casing, a field magnet comprising a head, pole pieces branched therefrom, regulator coils carried upon an extension of the head and an armature working between the pole pieces.

595,751. WATTMETER; E. K. Adams, New York, N. Y. App. filed Sept. 11, 1897. The combination in a wattmeter of a device capable of movements corresponding to the amperes, and a device capable of movements corresponding to the volts of the current in a circuit to be measured, means for converting these movements into displacements corresponding in extent to the logarithms of the numbers of the amperes and volts respectively, which produce them, and a pointer or arm moved thereby through angles proportionate to the sum of such displacements.

595,777. ELECTRIC SWITCH; H. F. Kleinschmidt, Hamburg, Germany, App. filed Nov. 16, 1896. In combination, a channeled rail conductor, a main conductor or feeder extending along the channel of said rail conductor and a switch box supported by the feeder, said parts braced against the upper and lower flanges of the rail conductor.

595,803. AUTOMATIC SWITCH FOR ELECTRICAL APPARATUS; S. L. Barriett, New York, N. Y. App. filed Sept. 9, 1897. In a switch for electric apparatus in combination with an arm moving over successive contact points, and an electromagnet having a curved segmental band armature, which acts to maintain said arm on contact with any one of said contact points against the action or force to return the arm to off position.

595,812. METHOD OF AND APPARATUS FOR CONVERTING X-RAYS INTO LIGHT FOR PHOTOGRAPHIC PURPOSES; T. B. Kinraide, Boston, Mass. App. filed Jan. 17, 1897. The method of taking an X-ray radiograph, which consists of interposing the object to be copied, and a photographic plate or substance between the source of the X-rays and a surface or converter, which transforms the invisible X-rays into light.

595,820. GYROSCOPIC CONTROLLED FIRING MECHANISM FOR SHIPS' GUNS; L. Obry, Pola, Austria-Hungary. App. filed Sept. 28, 1895. An apparatus for automatically discharging ships' guns when one or both of the main axes of the ship are in a horizontal position, consisting of a gyroscope, mounted so as to be free to retain its position irrespective of the movement of the ship, a contacting device in the igniting circuit to the guns and means for utilizing the relative motion of the ship and gyroscope to operate the said contacting device, so as to make contact when the vessel is in a horizontal position.

595,821. METHOD OF AND APPARATUS FOR MULTIPLE METERING OF ELECTRIC CURRENTS; E. Oxley, Washington, D. C. App. filed Oct. 25, 1897. In a system of electrical distribution, the method of controlling the metering or registering devices, which consists in electrically operating a control apparatus from a single point by circuits composed of one or the other of the mains of the system in conjunction with the ground.

595,827. INSULATOR BRACKET; C. A. Woolsey, Brooklyn, N. Y. App. filed March 29, 1897. A device comprising a base adapted to be permanently secured, provided with a seat for the wire, pipe or other material to be supported, a removable cap to co-operate with said seat, and means permanently mounted on said base to move said cap and seat relatively toward each other into fixed clamping adjustment.

595,841. ELECTRIC METER; W. S. Weston, Chicago, Ill. App. filed May 24, 1897. In an electric meter, the combination with a registering train, of an electric motor for driving the train having armature loops, composed each of a primary circuit and two or more separated derived or divided circuits, the latter being of material whose conductivity is varied or affected by the magnetic field, thus producing a state of unequilibrium between the accelerating impulse, caused by the current flowing in one direction through the primary circuit, and the opposite or retarding impulse caused by the current flowing in the opposite or return direction through the several derived or divided circuits of the loop, as each loop is brought within the influence of the field.

595,842. CIRCUIT CLOSING DEVICE FOR BURGLAR ALARMS; E. E. Wilson, Blackwood, N. J. App. filed Aug. 18, 1897. In a window spring or circuit closing device for burglar alarms, a plate having an opening therein, a spring secured at one end to said plate, a cam pivoted to the other end of said spring, and projecting through said opening, a contact pice having one limb secured to, but electrically insulated from, said plate, and its other limb adapted to be in contact with the said cam, when the latter is raised by an upward movement of a sash, and an electric circuit having an alarm therein and connections with said contact piece and plate.

595,868. REVERSING AND CUTTING OUT SWITCH FOR ELECTRIC MOTORS; T. von Zweibergk, Cleveland, Ohio. App. filed Sept. 20, 1897. The combination of a controller, a plurality of motors, and a switch in the circuit between the controller and motors, said switch governing in sets the individual connections of different motors, and said controller governing the connections between the sets collectively.

595,871. ELECTRIC BURGLAR AND FIRE ALARM; C. J. Bukoutz, Lamoille, Ill. App. filed April 19, 1897. An automatic electric fire and burglar alarm system, comprising a telephone call provided with a shaft and crank arm, a spool or drum loosely mounted on said shaft and provided with a cord and weight, a removable pin, a pivoted pawl adapted to project into the path of said arm, and a spring connected to said pawl in combination with a combustible cord having one end fixed to said pawl and the other end connected to a door, window or other suitable point within the premises.

595,874. ELECTRIC ELEVATOR; A. L. Duwelius, Cincinnati, Ohio. App. filed Feb. 18, 1892. The combination with a constant potential line circuit of a series motor, an electric switch adapted to disconnect the line circuit and close an independent circuit, including the armature in series with a field of variable magnetic strength, thereby converting the motor into a self-excited generator, adapted to be driven by the movement of the elevator.

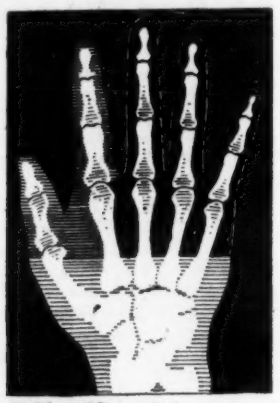
595,887. HIGH TENSION SWITCH; H. Muller, Nuremberg, Germany. App. filed June 2, 1897. A switch for high tension currents, consisting of groups of contact rollers made from easily oxidizable non-arcing metal, said groups of rollers being mounted on spring arms, each roller being normally out of contact with each other, while simultaneously a turning motion is imparted to the same.

595,898. ELECTRIC MOTOR; F. E. Wipple and C. A. Stauffer, Philadelphia, Pa. App. filed May 1, 1896. In an electric motor, a stationary external armature, having three or more electrically disconnected coils, a common terminal, means for establishing an electrical connection between one end of each of said coils, and the said common terminal, and a central revolving field.

595,936. ELECTRIC ARC LAMP; A. Blahnik, Paris, France. App. filed July 10, 1896. In a regulating apparatus for arc lamps, the combination with a pulley of two rotary discs formed of magnetic metal, and eccentrically supported on each side of the pulley, a flexible band lying upon the peripheries of said pulley and discs, means for applying tension to the band, and an electromagnet and armature arranged to exert attraction on the discs proportioned to the variations in the current intensity.

595,963. ELECTRIC BURGLAR ALARM; D. W. McCaughey,. Chicago, Ill. App. filed Nov. 27, 1896. In an electric burglar alarm, the combination of a terminal or contact point, a longitudinally movable insulating block, in which it is mounted, a hard metallic sleeve for protecting one end of the insulating block, and an outer hard metallic tube in which the parts are mounted for protecting the same.

595,970. PLUG CUT-OUT; F. S. Richmond, Chicago, Ill. App. filed Jan. 8, 1897. The combination with a base plate, provided with an opening or socket, of a contact terminal in the bottom of said socket, a terminal resting against the front face of said base plate, a plug carrying the cut-out and provided with a shouldered portion at one end, and with an insulating body portion extending beyond said shouldered portion, and adapted to fit within said opening or socket, a ring mounted upon said shouldered portion, and adapted to engage the contact terminal on the face



No. 595,812.—Method of and Apparatus for Converting X-Rays into Light for Photographic Purposes.

of the base plate, and a contact provided in the end of said projecting body adapted to engage the contact in the bottom of said socket mechanically, as well as electrically to hold the plug in place, whereby the projecting insulating body of the plug rests in the opening or socket to separate and isolate the oppositely charged terminals.

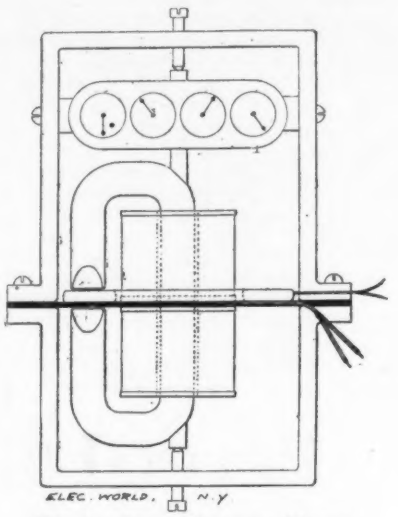
595,983. TELEPHONE REPEATER; W. H. M. Weaver, Macon, Ga. App. filed Sept. 4, 1897. A telephone repeater, comprising two or more stations, each equipped with a receiver and an induction coil transmitter, intermediate repeating devices, comprising two receivers and two induction coils with their primary wires extending to and provided with contact devices operated by the diaphragms of the said receivers of the repeating devices, each receiver and induction coil of the repeating device being in the main line circuit of one station and a common return circuit connecting the main circuit at each station at a point between its receiver and transmitter, with the main circuit between the receivers and induction coils of the repeating devices, and also connecting the main circuit between the receiver and induction coil of one side of the repeating device with the main circuit between the receiver and induction coil on the other side of the repeating devices.

596,002. ELECTRICAL TRANSMISSION OF ENERGY; R. M. Hunter, Philadelphia, Pa. App. filed Nov. 9, 1887; divided and refiled July 28, 1891. The combination of means for generating currents of electricity, of high tension, a line circuit leading therefrom to a distant place, induction apparatus for reducing potential of said line current, a local circuit supplied with the low tension induced current from said induction apparatus, translating or current consuming devices arranged in the local circuit, an induction coil having its coarse wire connected with the local circuit and in parallel with the translating or current consuming devices, and a high tension circuit connected with the fine wire of the induction coil and supplying current to a second local circuit insulated from the other.

596,017. TELEPHONY AND TELEGRAPHY; M. Hutin and M. Leblanc, Paris, France. App. filed Jan. 31, 1896. The method of transmitting messages consisting in passing over a line waves of alternating or varying current of such high frequency as only slightly affect the receivers and modifying the amplitudes of these waves in accordance with the desired message.

596,032. INDUCTOR GENERATOR; P. W. Power, Pittsfield, Mass. App. filed Sept. 10, 1897. In an inductor generator, the combination of a shaft or inductor carried thereby consisting of two parts separately mounted thereon, the place of division being at right angles to said shaft, either of said parts being laterally movable on said shaft, and journal boxes supporting said shaft at a considerable distance from said moveable parts when the same are in operative position.

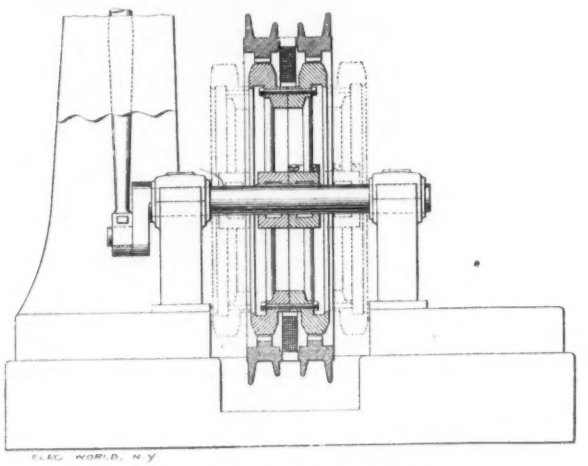
596,036. AUXILIARY APPARATUS FOR SELECTIVE ELECTRICAL SIGNALS; G. W. Whittemore, Brooklyn, N. Y. App. filed Sept. 2, 1897. In a party line telephone system, a telephone lock out appliance, comprising an automatic switch lever, in combination with an electromagnet having two reversely wound or connected coils in branches extending from the main circuit conductors respectively to a ground connection; a second electromagnet having a single coil contained in said ground connection; an actuating armature for the said double-wound electromagnet; a hook or de-



No. 595,841.—Electric Meter.

tent lever attached thereto; an armature or shutter, for the said single-wound magnet, normally held in its forward position by the said hook lever, but adapted to move into its backward position when released therefrom by the operation of the said actuating armature, and to be restored to its forward position by the direct attraction of the single-wound magnet; and a locking pin carried by the said shutter armature, and adapted to lock and unlock the switch lever, according as the said armature is in its backward or forward positions.

596,041. ELECTRICAL TRANSMISSION OF ENERGY; R. M. Hunter, Philadelphia, Pa. App. filed Oct. 4, 1889. The combination, with means to produce and maintain a continuous current, and means to convert it into high-tension currents of alternately rising and falling potential, of a conductor for conveying said currents, an induction coil having its fine wire



No. 596,032.—Inductor Generator.

in circuit with the line, a local circuit permanently closed when working, including the coarse wire of the induction coil, and a translating device in said local circuit.

596,042. TRANSMISSION OF ELECTRICAL ENERGY; R. M. Hunter, Philadelphia, Pa. App. filed June 18, 1887; divided and refiled April 20, 1892. The improvement in the art of transmitting electrical energy to and utilizing it at a distance from the source, which consists in generating maintained and practically uniform currents of high tension at one station and sending the same over a line of conductors to another station, and generating maintained and practically uniform currents of lower tension at the same station by the inductive influence of the high tension currents.